Structural empirical models of spatial inequalities: housing choices, policies and generational consequences

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STRUCTURAL EMPIRICAL MODELS OF SPATIAL INEQUALITIES: HOUSING CHOICES, POLICIES AND GENERATIONAL CONSEQUENCES

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Introduction

Housing has a genuine set of characteristics that make of it one of the most complex good to analyze. This complexity imposes several constraints on the modeling choices. First, its duality (serving both the purposes of consumption and investment) combined with its durability implies the existence of different tenures. The segmentation between agents who are willing to consume or/and to invest into housing raises the issue of tenure choice. Moreover, the cost of housing implies to consider the access to credit market for the needy ones. Finally, the strong heterogeneity of housing allows for another segmentation based on the individual income and the position in the life-cycle. As a consequence, any model designed to study housing should incorporate heterogeneous agents making life-cycle decisions, and therefore be dynamic.

The housing market cannot be considered as a frictionless market. It is on the contrary subject to several types of frictions. First, an informational asymmetry, related to the unobservability of some housing or buyer attributes, exists. Second, finding a house requires a search effort and therefore generates a cost. After having found a house, the individual has to bear the adjustment cost of possessing two houses at the same time in order to move her belongings. Third, there is a moving cost associated to the mobility. Finally, there are large amounts of transaction fees when buying or selling a dwelling. All these frictions act as incentives to reduce the number of transitions in the housing market. The main modelling implication of these frictions is to agents to look-forward when taking decisions.

Finally, a house is spatially fixed. Each house belongs to a neighborhood and to a local labor market. The location of a house is a fundamental determinant of its price. Several mechanisms explain this reality. In the literature, various items have been mentioned such as the accessibility to job-centers, and neighborhood amenities (presence of schools, stores, connection to public transportation). Other types of neighborhood characteristics (green areas, characteristics of the neighbors) have an important impact on prices. The major consequence of this pricing scheme is its potential segregation implication. Therefore, how agents value each of the neighborhood amenities is of primary interest in order to understand the mechanism of segregation.

What remains unclear is the precise role of the labor market in residential segregation. The sense of causality between segregation and bad local labor market outcomes is not clear. A convincing mechanism is the one of spatial mismatch, which is related to the disconnection between job centers and the location of some individuals. In the literature, several inputs have been used to produce spatial mismatch (difference in firm's entry cost between locations, individual search effort, relocation costs). And yet, depending on the mechanism at play, the cure in terms of policy may be completely different. All these mechanisms require to build models in order to be able to disentangle among several potential explanations.

To summarize, in order to take into account the complexity of the housing market, we need to build models where forward-looking agents choose their locations and housing attributes. I will refer to this class of model as structural to emphasize the fact that the individual behavior is derived from the outcome of a model. Once controlled for the neighborhood unobserved characteristics, the role of the labor market in spatial inequalities can be analyzed. One shall try to take into estimation the former models using survey data.

From these observations, it is clear that the housing market is at the heart of several inequality mechanisms, and especially the ones within and between cities.

In this thesis, I develop structural models to investigate three topics related to the spatial dimension of housing and the related inequalities. In the first essay, we propose a new methodology to estimate individual valuation of housing features. In the second, I study how a policy, namely the French Enterprise Zones, has been able to affect individual job market prospects in the presence of search and spatial frictions. Finally, in the third essay, I develop a general equilibrium model that includes the housing characteristics described before and studies the implication in terms of long-run inequalities.

These models are similar in the way to think of individual choices as the solution to an optimization problem. However, they differ substantially in the used modeling strategy. The first essay is a partial equilibrium model of the housing market where our primary focus is on individual choices. The transitions in the labor market are not considered. In the second, I develop a general equilibrium model of the labor market. The individual choices in the housing market are considered, but are not derived from a formal model. In the third, I consider a general equilibrium model of all labor, housing and education markets where agents are heterogeneous with regard to several dimensions. There is no construction sector, the dynamics of prices are instead based on individual forward-looking expectations of price sequences.

When taking these models into estimation, I face several challenges. The first is related to the quality and exhaustivity of the data. Indeed, the spatial dimension is crucial in my analysis. Moreover, I am interested in several variables describing the events over the life-cycle. Since the available data are topic-specific (housing, labor, wealth), all the necessary variables are not available in a single dataset. As a consequence, the working samples are composed of several datasets with the inherent inconsistencies. Finally, the lack of a dataset that records individual mobility in the housing market over time has been a great source of frustration. Thus, the essays consider innovative methods to handle individual mobility, either by using modelling tricks that avoid the need to know the next location or using moments over a long period to fit individual mobility patterns.

Second, another important issue is related to the computation time. In the models considered, rational agents make inter-temporal choices solving a recursive problem over a long period of time. This is highly demanding in terms of computing time. In the first essay, we use the classical maximum likelihood estimation techniques. In the second, I develop a multi-stage estimation algorithm that combines a hierarchical Bayesian method with moment matching and a generalized additive model for policy simulation purpose. The final essay is not estimated, but the resolution of the model, especially the recovering of the prices, is fastened using a cluster.

I can now turn to a more detailed description of the essays.

In the first essay, we propose a new method for identifying individual willingness to pay for the characteristics of a housing unit, including the neighborhood attributes in a hedonic framework. Since the seminal work of Rosen (1974), economists have been interested in the estimation of the willingness to pay for housing characteristics. The existence of unobserved housing characteristics that may be correlated with the observed ones makes the identification issue complicated. In a subsequent work, Brown and Rosen (1982), and later Epple (1987); Bartik (1987b) argue that identification can be achieved using multimarket data, linearized first order conditions, and an additional instrument for handling the simultaneity of the market equilibrium.

During the nineties, two advances in the literature generated a new perspective on the latter identification problem. First, the work of Manski (1993) raises the issue of how to measure the willingness to pay for neighborhood attributes when individuals sort in space according to both observed and unobserved characteristics. Second, the outstanding analysis of Berry, Levinsohn, and Pakes (1995) introduces an original way of handling unobserved characteristics in a market with differentiated and durable goods like housing.

Later, in an innovative paper, Ekeland, Heckman, and Nesheim (2004) shed a new light to the types of identifying assumptions that are necessary to learn about the parameters that characterize supply and demand in hedonic models. The results demonstrate that identification can be achieved in the same framework as Rosen. In order to achieve that, several assumptions are needed. First, all characteristics should be observed. Second, a nonlinear relation between prices and observed characteristics is needed. Finally, one needs additivity and separability in the utility function. In a companion paper, Heckman, Matzkin, and Nesheim (2009) relax both additivity and separability. In that case, identification is possible only with multimarket data. The main insight from the framework of these two papers is that in equilibrium, there is a nonlinear relationship between the optimal demand for observed housing characteristics, the prices and the individual observed characteristics. Indeed, in this economic structure, the individual observed characteristics act as an exogenous shift in the marginal price schedule. In real data, such a feature is rare.

A different strand of the literature implements BLP style model into housing demand and location choice. Bayer, Ferreira, and McMillan (2007) use such a strategy, exploiting the geographical boundaries for handling the endogeneity of school choice, and the endogeneity of price is dealt with using prices in different markets. However, this estimation is subject to the incidental parameter problem since a housing specific effect is estimated for each housing unit.

In the first essay of this thesis, we develop an estimation method that helps to overcome the limits mentioned above. Namely, we estimate a dynamic hedonic housing model with unobserved heterogeneity. In contrast to the former literature, we build a dynamic model of mobility decision along with a hedonic model of housing valuation. Our approach follows Melnichov (2000) and separates the individual's choice problem into an optimal stopping problem in the decision to stay or to move and a hedonic model of housing choice and valuation. First, the conditional choice probability of whether to stay or move along with the length of stay identifies the preference parameters. Second, the rent regulation creates an effective independency between market conditions and the level of rent. We carried the estimation using the 2002 and 2006 French housing surveys.

The estimation results demonstrate that the observed and unobserved housing characteristics are negatively correlated. Failure to take into account the endogeneity bias could underestimate the true value of the observed characteristics of housing.

After highlighting the importance of segregation, in the second essay, I propose a model to evaluate a policy aimed at decreasing the heterogeneity between locations in the labor market outcomes. Starting in 1996, the French government implemented an Enterprise Zones Policy in order to circumvent the potential spatial mismatch problem affecting the neighborhoods located in the inner cities. In practice, the policy offer tax cuts to firms located in Enterprise Zones. There is a large controversy in the literature on the effectiveness of these kinds of policy. The survey by Papke (1993) reports a positive effect on the firm creation, while there is no consensus as to the impact on unemployment.

I depart from the preceding literature by starting with the premises that the labor market is characterized by considerable frictions, and the housing market is subject to considerable amount of relocations. As a consequence, the standard treatment effect may not be suited for the evaluation of these kinds of policies.

I develop and estimate a dynamic general equilibrium model of individual choices in the labor market along with a location choice model of individuals and firms. I investigate to which extent the French Enterprise Zones (FEZ henceforth) policy has changed individual prospects in the labor market.

I bring together the literature on estimable equilibrium search models (Bontemps, Robin, and van den Berg, 1998; Postel-Vinay and Robin, 2002), and the urban equilibrium model of matching (Coulson, Laing, and Wang, 2001; Smith and Zenou, 2003). The evaluation is based on a comparison between my estimates of the labor market primitives after the policy implementation to a prediction of their value before the policy introduction.

In the model I developed, each urban area is considered as a local labor market that consists of a central location and a deprived inner suburb. I allow individuals and firms to choose their location as a response to the policy. Also, individuals can commute between both locations at no null cost. The main consequence of the policy for firms is to change the rate of corporate, payroll and business taxes. I model the firm location choice as the outcome of a dynamic discrete choice model where the constraints imposed by the policy are endogenized. I introduce several channels under which a segmentation in a local labor market is possible. First, I assume that there are agglomeration externalities on the firm side, that result in a difference between the total number and the mean productivity of firms across locations. In conjunction, I posit that there are informational and search frictions resulting in a lower job arrival rate when the firm and individual locations differ. The specific matching function between firms and individuals takes into account both the tensions in the market and the physical distance between the residential and job locations.

The results show that the governmental diagnostic was right, while the effectiveness of the cure is questioned. That is, the estimates show a large discrepancy between the areas subjected to the policy and the rest of the urban space. In the evaluation part, I show that the increase in the number of firms has very little effect on unemployment. According to the model, the number of firms in the ZFUs should be multiplied by at least 20 before expecting any decisive effect. Moreover, the model highlights the importance of the physical distance between individuals and jobs. Given the challenges ahead of the French Enterprise Zones, a change in policy should be considered.

In the final essay, I investigate the consequence of spatial inequalities on the level of long-run inequalities. There is a large number of mechanisms underlying the formation of inequalities. I focus here on the spatial ones when interactions at a small geographical level generate differences in education and labor markets outcomes. The role of social interactions in generating inequalities is largely admitted, while most of the time ignored when modeling individual behavior. A notable exception is provided by Benabou (1993, 1996) who showed how powerful this tool is in generating an equilibrium distribution of income in space while highlighting interdependencies and complementaries between housing, labor and education markets.

The interactions between housing, labor and education play a central role in these inequalities. Empirical work has investigated the extent to which differentials in housing prices across jurisdictions reflect differentials of school quality, see e.g. (Bayer, Ferreira, and McMillan, 2007) and (Black, 1999). Even though there is no agreement on the magnitude of the willingness-to-pay for each neighborhood feature, everyone recognizes the characteristics of a neighborhood as major determinants of housing prices. Therefore, the interaction between the neighborhood features and prices plays an important role in inequalities between locations, that is, the distribution of wealth over locations.

In this essay, I develop an overlapping generation model to study the effects of social interactions on the dynamics of inequalities across individuals, locations and generations. I include in the standard life-cycle model heterogeneous agents, a realistic housing market, aggregate uncertainty and a bequest motive. Moreover, the locations are heterogenous with regard to their level of social capital, that influences household labor productivity and the level of human capital of the next generation.

At the household decision level, the key mechanism underlying my model is the trade-off between the level of social capital and housing prices. Some households may be finance constrained due to the cost of a housing unit. The fixity of supply in each neighborhood combined with the borrowing constraints prevent some households from living in their preferred area, which leads to segregation.

Moreover, the discrepancy in school quality between locations leads to differences in the next generation level of human capital. Therefore, the effects of borrowing constraints are strengthened by their implications for parents but also for children.

My results show that the model performs well in explaining homeownership, unemployment and price dispersion. They also show that the current homeownership rate is higher than its equilibrium level, and the equilibrium prices will be more dispersed with a clear segmentation between low-price locations and high-price neighborhoods. A decomposition of the lifetime inequality shows that the initial endowment in inheritance explains more than 60% of long term inequalities, while the spatial inequalities account for approximately 25% of the overall inequalities. I carry several experiments using the model. One of the most interesting results is related to the model with no borrowing constraint. That is, the main consequence of relaxing borrowing constraints is to increase the level of prices. This outcome may be the explanation of the rise in housing prices observed in the majority of the developed countries before the 2008 crisis. Among all the policies considered, a mix of bequest taxation and social mixity would provide an efficient control for the spatial and generational inequalities.

Essay 1

Estimation of Dynamic Hedonic Housing Models with Unobserved Heterogeneity

Introduction

In this essay, we are interested in the hedonic identification of individual willingness to pay for housing observed and unobserved characteristics which is central to the understanding of the mechanism of segregation. We propose a new methodology to estimate a housing demand model with unobserved housing characteristics, which also includes unobserved neighborhood attributes. Most of the literature on location choice, such as Bayer, Ferreira, and McMillan (2007) or Bajari and Kahn (2005), analyzes individuals who choose in which house among all housing units to live or, in a more simplified setting, choice probability of each housing unit is a function of unobserved housing characteristics of all available housing units. Even in the simpler setup of neighborhood choice, the choice probability is a function of unobserved neighborhood characteristics in all neighborhoods plus other structural parameters. Estimation of these models is extremely complex due to the large number of choices, since the number of housing units or, even in a simplified model, the number of neighborhoods is usually large, thus causing finite sample difficulties. Often, strong assumptions on the error term of the utility function need to be imposed.

To overcome this, we follow Bayer et al. (2009) and estimate a dynamic model of housing demand. Their framework, inspired by Carranza (2006), separates the individual's problem into two distinct choices: an optimal stopping problem in the decision to stay or move; and conditional on this decision, a static discrete choice over where to move, which follows the static location choice model of Bayer, Ferreira, and McMillan (2007). In contrast to Bayer et al. (2009) and other literature, we use the following two features of the data as the main sources of identification. First, we use the conditional choice probability of whether to stay or move as well as the housing tenure information. Since the mobility decision depends only the housing characteristics of the current housing unit, the estimation problem becomes much simpler. It consists in recovering for each housing unit one housing specific characteristic parameter based on one conditional choice probability of moving out. The dynamic choice problem of staying or moving out does not increase its complexity with the number of housing units or neighborhoods at all. This greatly helps identification and estimation. This is in contrast to the conventional location model where choices are over all housing units. There, choice probability of each house is a function of unobserved housing characteristics of all housing units.

Second, we use both the observed housing characteristics and the housing location information. That is, we combine the static hedonic literature and the dynamic mobility choice literature. The conventional static hedonic approach by Rosen (1974), Epple (1987), Bartik (1987b) and others, only uses data on the choice of observed housing characteristics, and thus have difficulties in dealing with unobserved housing characteristics. They have to assume that unobserved housing characteristics are independent of the observed ones. By using both the tenure and mobility choice data and the housing characteristics data, we can allow for correlation between observed and unobserved housing characteristics. We also recover flexibly specified hedonic per period utility function and the individual specific utility shocks as well, when assuming the conventional separability between housing and individual characteristics Otherwise, the literature requires multimarket data and the assumption that the distributions of observed individual and housing characteristics vary across market while the distribution of unobserved characteristics do not. In our analysis, as we account for the correlation between observed and unobserved housing characteristics, we only need data on one housing market.

The two separate features of the data source are complementary in identifying the model. Mobility and tenure information helps to identify hedonic utility function of housing units because individuals whose deterministic utility of housing consumption is high, stay at the housing unit longer. If we had just used the discrete mobility data, then we would have only been able to identify the finite mixture distribution or parametrized distribution of unobserved heterogeneity of each housing unit. By using additionally housing characteristics data, which comes from the continuous choice of individuals, we are able to recover the unobserved characteristics of each housing unit, and the individual taste shocks as well.

We use data on rental apartments from the French Housing Survey. We exploit the strong rent control regulation in France, which makes the rent effectively invariant to changes in local economic conditions. Therefore, we do not need to worry about the endogeneity of rent in the mobility decision due to the housing specific unobserved heterogeneity. Therefore, we avoid the need for an instrument for price of a housing consumption, which has always been a difficult issue in the housing literature.

1.1 Housing demand models with unobserved heterogeneity

1.1.1 The Literature of Hedonic Model of Housing

We briefly review the literature on housing demand using the hedonic framework. The analysis of hedonic models was pioneered by Rosen (1974). In this paper, Rosen suggests a two-step estimation to recover preferences parameters. In the first step, the marginal price function is recovered from the regression of price on attributes. Then, the first-order-conditions (FOC) are used to estimate the utility function. However, as noted by Brown and Rosen (1982), the second stage suffers from a simultaneity issue. Hence, Brown and Rosen (1982) argue that using a linear approximation of the first order conditions, relying on multi-markets data. In order to achieve identification with multi-market data, it is necessary to assume that the preferences parameters are common across markets while individual heterogeneity varies across markets. Subsequently, Epple (1987) and Bartik (1987b) argue that the model is still not identified because unobserved tastes affect both the quantity of an amenity consumed by an individual and its price. Hence, they suggest to use instrumental variables.

The current literature departs from the preceding one in two directions: by using nonparametric methods instead of a linear approximation of the FOC (Ekeland, Heckman, and Nesheim, 2004; Heckman, Matzkin, and Nesheim, 2009), and by allowing for unobserved heterogeneity (Bayer, Ferreira, and McMillan, 2007).

Let's introduce some notation based on Ekeland, Heckman, and Nesheim (2004)'s model to make clear the identification issues. The individual's utility function of a house with observed characteristics z and utility shock ϵ is

$$U(z, x, c, \epsilon)$$

where x is the vector of individual observed characteristics and c is the non-housing consumption. An individual maximizes her utility subject to the following budget constraint:

$$c + P(z) \leq y$$

where the price of non-housing consumption c is normalized to one. Then, the first order condition that allows to recover housing demand is

$$P_z(z) = h(x, z, \epsilon) \equiv \frac{U_z(z, x, y - P(z), \epsilon)}{U_c(z, x, y - P(z), \epsilon)}$$

Ekeland, Heckman, and Nesheim (2004) show that hedonic models with an additively separable utility function are nonparametrically identified with single market data and present two methods for recovering the structural functions in such models. Heckman, Matzkin, and Nesheim (2009) relax the additivity assumptions, and show that only multimarket data identifies all parameters of the model. As stated before, the underlying assumption for the identification based on multimarket data is that the observed individual or housing characteristics need to be differently distributed across markets but the unobserved individual or housing characteristics need to remain the same. Moreover, another implicit assumption in the models of Ekeland, Heckman, and Nesheim (2004) and Heckman, Matzkin, and Nesheim (2009) is that all housing characteristics z are observable. In this setup, it is important to note that ϵ cannot be interpreted as the unobserved housing characteristic since it is not included in the price function. If the individual knew that the price of unobserved characteristics was zero, she would consume it at the bliss point and thus the distribution of ϵ would be degenerate If we include ϵ in the price equation, then the price equation becomes

$$P(z, \epsilon) = \delta_z z + \delta_\epsilon \epsilon$$

This is the price equation analyzed in Epple (1987). Applications of this model include Bajari and Kahn (2005), who use nonparametric methods to estimate the coefficients δ_z and interpret the residuals as the unobserved housing characteristics. Once unobserved characteristics are known, then one could just proceed to estimate the parameters in the standard way discussed above. However, to consistently estimate the coefficients of the price equation requires dealing with the correlation of z and ϵ this is way Epple (1987), Bajari and Kahn (2005) assume that they are not correlated with each other.

The major difficulty is to allow for correlation between z and ϵ. This requires an instrument, that is, a variable correlated with the observed housing characteristics z but uncorrelated with the unobserved housing characteristics ϵ.

Another strand of the literature, pioneered by Bayer, Ferreira, and McMillan (2007), tries to estimate the unobserved housing characteristics directly from the housing choice of the individuals. Denote the observable housing characteristics of a housing unit j to be z_j and the unobservable characteristics to be η_j. Since η_j are not observable, Bayer, Ferreira, and McMillan (2007) follow the convention of the discrete choice literature and specify the housing specific unobserved heterogeneity η_j.

Then, the optimal housing choice of an individual i can be expressed as follows:

$$k = \underset{j}{argmax}\{U(z_j, x_i, y_i - P(z_j, \eta_j, w_j), \eta_j, \epsilon_{ij})\}$$

where ϵ_{ij} is the individual i specific utility shock for housing unit j, which is assumed to be i.i.d. extreme value distributed. Now, the price is a function of both the observed characteristics s z_j and unobserved characteristics η_j and a price shock w_j. Furthermore, they assume that

$$U(z_j, x_i, p_j, \eta_j) = V(z_j, x_i, p_j) + \eta_j + \epsilon_{ij}$$

where $p_j = P(z_j, \eta_j, w_j)$. Then, household i's choice probability of a housing unit k equals

$$p(i,k) = \frac{\exp[V(z_k, x_i, p_k, \eta_k)]}{\sum_l \exp[V(z_l, x_i, p_l, \eta_l)]}$$

The maximum likelihood estimation is then based on the above household choice probability over all the housing units in the data. The estimation follows Berry, Levinsohn, and Pakes (1995), and the derivation of the housing unobservable is feasible thanks to the contraction mapping of Berry (1994). Notice that the number of housing specific heterogeneity terms η_j equals the total sample size of housing units, which makes the estimation exercise subject to the finite sample problem. [1]

[1] Bayer, McMillan, and Rueben (2004), after implementing the above estimation algorithm, hint that a potential approach that is not subject to the finite sample bias would be to assume that η_j follows a distribution that is nonparametrically estimated, for instance finite mixture. This would certainly avoid the finite sample problem mentioned above, but would also create an additional issue that $V(z_j, x_i, p_j) + \eta_j$ can no longer be obtained *à la* BLP style in the first stage using the contraction mapping, which may add complexity in the estimation.

In a more simpler setting, one could modify the specification of the housing specific unobserved heterogeneity as follows.

$$\eta_j = \xi_n$$

where ξ_n is the neighborhood specific unobserved heterogeneity. Even then, the estimation problem could be subject to the finite sample problem if the number of observations per neighborhood is small, which is typical in a disaggregated neighborhood level data. Furthermore, it is known that the logit choice framework imposes strong functional form (I.I.A.) on the utility function, which may distort the welfare calculation (see Ackerberg and Rysman (2005) for more details.).

Another issue in the estimation of the above location model is the endogeneity of the housing characteristics z_k, i.e. their potential correlation with the neighborhood specific unobserved heterogeneity. A proposed solution for the location-related characteristics is to rely on quasi-random variation like geographical boundaries (Bayer, Ferreira, and McMillan, 2007; Black, 1999). However, it is in general difficult to find an appropriate instrument for all other housing characteristics, such as number of rooms, since one has to find an instrument that is correlated with the observed characteristics but uncorrelated with the unobserved characteristics[2].

The literature that is the closest to our paper is Bishop (2010). This approach is based on the sorting model of Epple and Sieg (1999) which predicts the positive correlation between household's neighborhood quality and average permanent income of household's residence. The issue there is that the permanent income is not observed, and additional instruments are required since Epple and Sieg (1999) predict a negative within neighborhood correlation between observed and unobserved local income. Bishop (2010) estimates a dynamic model of location choice with moving cost. The estimation proceeds in two steps. In the first, a dynamic model of migration is estimated and a location

[2]For example, Bayer, Ferreira, and McMillan (2007) uses prices of far away neighborhoods as instruments, where the implicit assumption is that the unobserved characteristics of the far away neighborhoods are not correlated.

fixed effect is recovered. In the second, the location fixed effect is decomposed between observed and unobserved determinants using the same argument as Bartik (1987a). Nonetheless, in presence of individual sorting, the second step may still suffer from an endogeneity bias.

1.1.2 The Dynamic Model

Instead of identifying the structural parameters solely from the residential choice of the individuals, we additionally use the dynamic mobility choice, i.e. whether to stay in the same residential unit or move. Let τ be the length of stay in the neighborhood, and Z_i and w_i be the vector of the observed and unobserved characteristics of a housing unit i. We assume that the relative rent of apartment i depends on the length of stay τ, housing observed attributes and an unobserved component w_i :

$$r(\tau, Z_i, w_i)$$

In our framework, we consider the relative rent as an intuitive way to introduce the individual choice problem. That is, the rent considered here summarizes the fact that, when an individual stays longer, his rent relative to the cost of other housing units with lower length of stay decreases.

Furthermore, we assume that the relative rent of a housing unit is determined as follows

$$r(\tau, Z_i, w_i) = r_0(Z_i, w_i)g(\tau)$$

where r_0 is the rent at initial period, and $g(\tau)$ represents the over time change in relative rent, which is entirely determined by the regulated uniform growth rate of rent, where t_0 is the initial period. We let the period zero rent equation to be linearly separable between observed and unobserved heterogeneity, i.e.

$$r_0(Z, w) = h(Z) + v(w)$$

Where $h(Z)$ is a function of observed attributes, and $v(w)$ is the unobserved part of the rent equation. Then, the individual in each period makes the choice between staying and moving out of the house. Let the per period utility of staying in a house be specified as.

$$\gamma_1 r_i(\tau) + \frac{1}{2}\gamma_2 r_i(\tau)^2 + \mu_{i\tau} + \epsilon_{0\tau i}$$

where the first two terms represent the negative utility from paying the rent r_i, and the fourth term represents the per period utility shock. The third term is a function of observable and unobservable characteristics:

$$\mu_{i\tau} = [b(Z_i, X_{i,\tau}, u_{Z,i}) + u(w_i)]c(X_{i,\tau})u_i$$

where $c()$ is a function of individual observed characteristics $X_{i,\tau}$, $b()$ is the utility component for observed attributes, which is a function of housing observed characteristics Z_i and individual observed characteristics $X_{i,\tau}$. $u_{Z,i}$ and $u(w_i)$ are utility shocks that captures the fact that the effects of the observed Z, and unobserved w_i differ per individuals. u_i is the shock for the marginal utility of housing characteristics.

As we discussed before, we do not observe each component of the vector w_i. Given parameters of the rent equation $h()$, we can only recover $v(w_i)$, thus approximate the utility component of unobservable characteristics as follows.

$$u(w_i) \approx u_{v,i} v(w_i)$$

That is, the utility components of the renting and the preference function are assumed to be proportional. Thus, we estimate $v(w_i)$ the effect of unobserved heterogeneity on the price, and the proportionality parameter $u_{v,i}$ between $u(w_i)$ and $v(w_i)$. As a consequence, we can drop the term w_i without loss of generality. This setup is similar to the one where the utility function is linearly separable in other goods $x = y - r_i$ and a function of housing characteristics Z.

We denote the tenure invariant component of the rent as $r_i(0)$. Since the rent of all subsequent periods is a deterministic function of the initial rent, all the subsequent mobility choices are a function of $r_i(0)$. The choice specific value of staying is

$$V_0(r_i(0), X_{i\tau}, \tau, \mu_i, \epsilon_{0\tau i}) = \gamma_1 r(\tau, Z_i, v_i) + \frac{1}{2}\gamma_2 r(\tau, Z_i v_i)^2 + \mu_{i0} + \epsilon_{0\tau i} + \beta EV(r_i(0), \tau + 1, X_{i\tau+1}, \mu_i)$$

The value of moving out is

$$V_1(X_{i\tau}, \epsilon_{1\tau i}) = \varphi(X_{i\tau}) + \epsilon_{1\tau i}.$$

where β is the discount factor, φ captures the life-cycle effect and $\epsilon_{1\tau}$ is per period shock to the utility of moving out. We assume that since the individual is moving out of the current housing unit, the utility of moving out is not a function of its characteristics. Both $\epsilon_{0\tau i}$ and $\epsilon_{1\tau i}$ are assumed to be i.i.d. extreme value distributed.

Now, denote $\bar{V}_\tau$ the deterministic value of staying. That is,

$$\bar{V}_{0\tau}(r_i(), Z_i, \tau, X_{i\tau}, v_i) = \gamma_1 r_i(0) g(\tau) + \frac{1}{2}\gamma_2 [r_i(0) g(\tau)]^2 + \mu_{i\tau} + \beta EV(r_i(), Z_i, \tau + 1, X_{i\tau+1}, v_i).$$

Similarly, let $\bar{V}_{1i}$ be the deterministic value of moving out, i.e.

$$\bar{V}_1(X_i) = \varphi(X_i).$$

Then, the probability of leaving the house is

$$p(r_i(0), Z_i, \tau, X_i, \mu_i) = \frac{\exp(\bar{V}_1(X_i))}{\exp[\bar{V}_{0i}(r_i(0), \mu_{i0}, \tau, X_i)] + \exp(\bar{V}_1(X_i))} \tag{1.1}$$

During the period when the individual is looking for a house, he tries to find a housing unit that maximizes the following value function with respect to observed housing characteristics Z_i and unobserved housing characteristics v_i.

$$EV(X_i, u_i, u_{Z,i}) = argmax_{\{Z_i, v_i\}} EV(r_i, Z_i, u_{Z,i}, v_i, u_i, X_i, \theta) \tag{1.2}$$

Where θ is the set of parameters to be estimated. Here, we impose a restriction that there is only one unobserved characteristic v_i. That is, if there are several unobserved characteristics of the rental unit, individuals do not choose optimally the quantity of each of them, and thus they can be considered as an index. Finally, we assume that the individual's utility shocks u_i, $u_{Z,i}$ only get realized after she decides to move. We then specify the deterministic value of moving out as the difference between the expected value of a new house and the mobility cost, i.e.

$$\varphi(X_i) = E_{u_i,u_{Z,i}}[EV(X_i, u_i, u_{Z,i})] - C(X_i)$$

1.2 Data

We use two waves of the French Housing Survey 2002 and 2006. The French Housing Survey is a four years cross-section data that aims to describe the housing conditions of the population using a representative sample. Hence it describes the characteristics of the housing units (*size, area, tenure*, ...) and the characteristics of the individual living in these houses (*income, labor market outcome, children*, ...) including their former mobility (*length of stay, former tenure*, ...).

The main advantage of this data source is to locate individuals at the finest geographical level. However, the neighborhood attributes we rely on are computed from the census, and the finest geographical level available for census data is IRIS.[3] Therefore, a neighborhood is defined as an IRIS. For the sake of reliability, we get rid of individuals living in census blocks of less than 1,000 inhabitants.[4]

Our sample selection is as follows: we start with the 2002 and 2006 French Housing Surveys. We restrict our sample to tenants from private sector and for whom the location variable is available. This yields a sample of 12,084 households. Then we dispose of individuals who have a family relationship with their landlord (216), individuals older

[3]IRIS are the basic units for the dissemination of local data. Municipalities of at least 10,000 inhabitants and most municipalities of between 5,000 and 10,000 inhabitants are divided up to neighborhoods with a population close to 2000 inhabitants

[4]Neighborhood attributes are not reliable for them.

than 65 years (1,413), those who have been in the same dwelling for more than 30 years (123), and individuals who have been in their house before emancipation age (123).

Finally, to reduce the level of heterogeneity between markets, we dispose of all individuals living in rural areas (1,264).

Our final sample is composed of 8,288 individuals whose characteristics are described in table 1.1. We measure mobility using a prospective variable that yields a mobility rate of 24.8%, to be compared to 26% in the general population for the same sub-category.

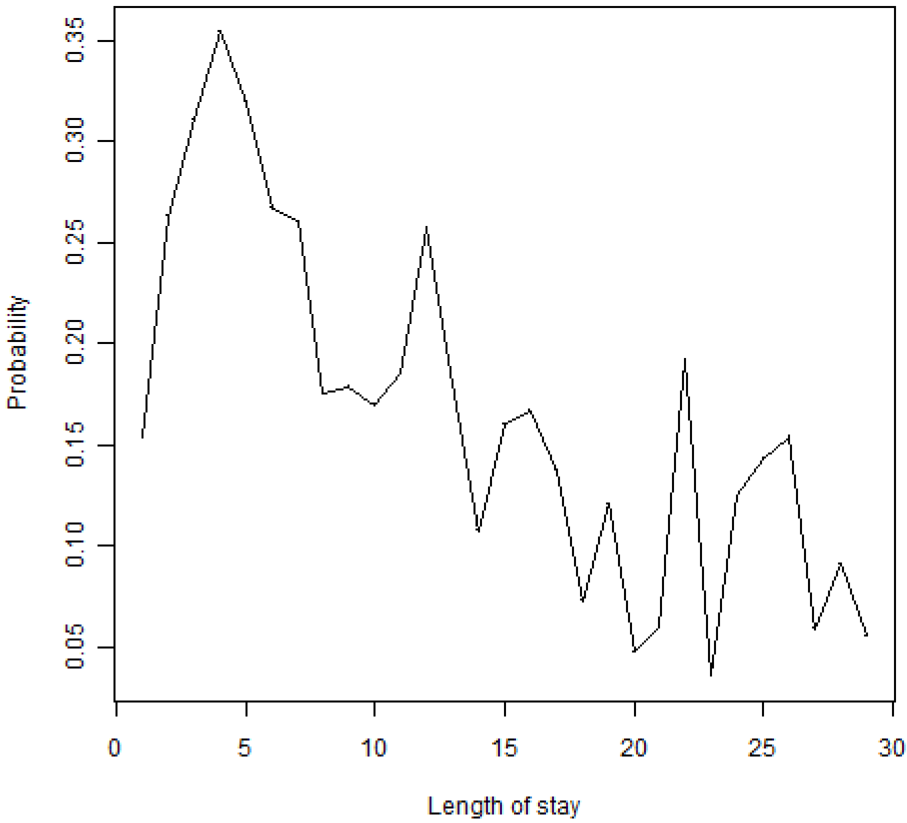
A large fraction of the mobile households have male household heads. A small share are either married or in cohabitations, which could mean that those households have a high mobility costs. Mobile households tend to be younger but the number of children is similar for mobile and nonmobile households. The ratio of immigrants is slightly higher among mobile households. Mobile households tend to be more educated. Mobile households tend to have smaller housing units than not mobile, which is consistent with the life-cycle housing demand.

Table 1.1: Description of the sample

Variables		Not Mobile Households	Mobile Households	All Households
Female		35.8	35.2	35.6
Married/cohab		45.6	48.7	46.4
Number of children	0	65.5	64.7	65.3
	1	15.8	17.2	16.2
	2	11.6	11.4	11.6
	3 and more	6.9	6.7	6.9
Citizenship	Native	87.0	85.9	86.7
	Immigrant	13.0	14.1	13.3
Age	Less than 30	34.0	44.1	36.6
	30 to 39 years	25.2	30.2	26.5
	40 to 49 years	20.6	15.7	19.4
	50 to 64 years	19.5	9.6	17.0
	65	0.7	0.4	0.6
Education	Intermediate	44.6	39.7	43.4
	Higher	18.1	19.1	18.4
	University	37.3	41.2	38.3
Number of rooms	1	19.2	26.8	21.1
	2	26.8	29.4	27.4
	3	27.7	23.8	26.7
	4	17.2	13.4	16.3
	5	6.7	4.8	6.2
	6	1.7	1.4	1.7
	7	0.7	0.4	0.6
Mean rent / 100 in (€)		5.52	5.40	5.49
Number of observations		6,188	2,100	8,288

In the next figure, we present the duration and the mobility data. The hazard rate turns out to decrease with tenure, indicating the presence of both observed and unobserved heterogeneity or a negative effect of decreasing rent over time on mobility.[5]

Figure 1.1: Estimation of the Hazard function



[5]The spikes at the tail of the hazard function are due to extremely low sample size in this area.

1.3 Identification

1.3.1 The French rental market

The French rental market is characterized by a large number of regulations. As noted by Wasmer (2005), these regulations are biased towards tenants. The major regulation takes the form of a winter recess during which landlords have to cope with unpaid bills. The second major characteristic, which is more of interest for our work, is related to the presence of a rent evolution regulation. Landlords have the power to set the initial rent of their dwelling. After the initial period, the rent evolution is given by a rent index calculated by the French Statistical Institute (INSEE) which during our period of study, was calculated by using the construction cost index.[6] This regulation has mainly two consequences. First, it reduces significantly the degree of uncertainty on future rents, and hence operates as an insurance against the rent shocks. A potential implication is to decrease the value of homeownership compared to renting. The homeownership rate in 2006 in France, close to 56%, is lower than in most of the developed countries. [7] Second, the rent regulation creates an exogenous variation paths for relative rent that is independent of market conditions. This is very useful in order to circumvent the endogeneity of rent.

1.3.2 Identification of the model

The identification is based on the optimal housing choice of an individual. That is, at the beginning of the period, an individual chooses a housing unit which maximizes her expected utility. Let's denote $v_i = v(w_i)$. Given the data on rents and housing observed characteristics, we can recover v_i from the initial rent equation as follows.

$$v_i = r_i(0) - h(Z_i)$$

[6] A change was introduced in 2006, the rent index is now based on the consumer price index for all goods except tobacco and shelter.

[7] The exceptions are very specific housing markets: Germany (price fallout after reunification boom), Netherlands (extremely high proportion of public housing).

We then use the following F.O.C. of the optimal choice of housing characteristics. The sensitivity of housing demand to the housing unobserved v_i, and observed Z_i can be written respectively:

$$\frac{\partial EV(r_i(0), Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i, \theta)}{\partial v_i} = -\frac{\partial EV(r_i(0), Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i, \theta)}{\partial r_i(0)} \frac{\partial r_i(0)}{\partial v_i}$$

$$\frac{\partial EV(r_i(0), Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i, \theta)}{\partial Z_i} = -\frac{\partial EV(r_i(0), Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i, \theta)}{\partial r_i(0)} \frac{\partial r_i(0)}{\partial Z_i}$$

Now, notice that the same can be derived using the utility shock to marginal utility

$$\begin{aligned}
\frac{\partial EV(r_i(0), Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i, \theta)}{\partial \mu_{i\tau}} &= \beta^{\tau} \frac{\partial EV(r_i(\tau), Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_{i\tau}, \theta)}{\partial \mu_{i\tau}} \\
&\times P(s \geq \tau, r_i, Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i) \\
&= \beta^{\tau} \frac{exp(\overline{V}_{0\tau})}{exp(\overline{V}_{0\tau}) + exp(\overline{V}_{1\tau})} \times P(s \geq \tau, r_i, Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i) \\
&= \beta^{\tau} P(s > \tau, r_i, Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i)
\end{aligned}$$

Where s is an index, and P is the moving out probability as defined before.

Hence, considering the relationship between μ and the unobserved housing characteristics v_i

$$\frac{\partial EV(r_i(0), Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i, \theta)}{\partial v_i} = \sum_{\tau=1}^{T} \beta^{\tau} P(s > \tau, r_i, Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i) c(X_{i,\tau}) \times u_{v,i} u_i$$

Furthermore, notice from the same relationship as before

$$\begin{aligned} & \frac{\partial EV(r_i(0), Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i, \theta)}{\partial Z_i} \\ = & \sum_{\tau=1}^{T} [\beta^\tau P(s > \tau, r_i, Z_i, v_i, u_{Z,i}, u_{v,i}, u_i, X_i) \times \frac{\partial b(Z_i, X_{i,\tau}, u_{Z,i})}{\partial Z_i}] c(X_{i,\tau}) u_i \end{aligned}$$

Therefore, assume the set of observed characteristics is of size J. We obtain for each element j of vector Z

$$\frac{\sum_{\tau=1}^{T} [\beta^\tau P(s > \tau,) \times b_{Zj}(Z_i, X_{i\tau}, u_{Z,i}) c(X_{i,\tau})]}{\sum_{\tau=1}^{T} \beta^\tau P(s > \tau,) c(X_{i,\tau}) u_{v,i}} = h_{Z_j}(Z_i) \tag{1.3}$$

Notice that there are $J + 1$ unknown variables, $u_{v,i}$, $u_{Z,i}$ with only J equations. Hence, without loss of generality, we normalize u_{z0} to be zero. Then, $u_{v,i}$ can be derived

$$u_{v,i} = \frac{\sum_{\tau=1}^{T} \beta^\tau P(s > \tau,) \times b_{Z_j}(Z_i, X_{i\tau}, u_{Z,i}) c(X_{i,\tau})}{\sum_{\tau=1}^{T} \beta^\tau P(s > \tau,) c(X_{i,\tau}) h_{Z_j}(Z_i)} \tag{1.4}$$

Lastly, we need to derive the utility shock parameter u_i.

$$u_i = -\frac{h'(Z) \sum_{l=1}^{T} \beta^l P(s > l,) [\gamma_1 + \gamma_2 r_i(0) g(l)] g(l)}{\sum_{l=1}^{T} \beta^l P(s > l,) \times b_Z(Z_i, X_{i\tau}, u_{Z,i}) c(X_{i,l})} \tag{1.5}$$

That is, substituting $u_{v,i}$ and u_i in the specification of μ, we get

$$\begin{aligned} \mu_{i\tau} &= [b(Z_i, X_{i\tau}, u_{Z,i}) + u_{v,i}(r_i - h(Z_i))] c(X_{i,\tau}) u_i \\ &= h_{Z_j}(Z_i) b(Z_i, X_{i\tau}, u_{Z,i}) c(X_{i,\tau}) \times \frac{\sum_{l=1}^{T} \beta^l P(s > l,)(-\gamma_1 - \gamma_2 r_i(0) g(l)] g(l)}{\sum_{l=1}^{T} \beta^\tau P(s > l,) b_{Z_j}(Z_i, X_{i,l}, u_{Z,i}) c(X_{i,l})} \\ &\quad + [r_i - h(Z_i)] c(X_{i,\tau}) \times \frac{\sum_{l=1}^{T} \beta^l P(s > l,)[-\gamma_1 - \gamma_2 r_i(0) g(l)] g(l)}{\sum_{l=1}^{T} \beta^l P(s > l,) c(X_{i,l})} \end{aligned} \tag{1.6}$$

Given $\mu_{i,\tau}$, we then can derive the likelihood of the dynamic discrete choice model where the probability of moving out after tenure τ is

$$p(r_i(), Z_i, X_i, \tau, \mu_i) = \frac{exp(\bar{V}_1(X_i))}{exp[\bar{V}_{0i}(r_i(0), Z_i, X_i, \tau, \mu_i)] + exp(\bar{V}_1(X_i))}$$

Let us make several remarks about the above identification strategy. First, it is the predicted change over time that identifies the rent coefficient γ. That is with a time varying observed individual characteristics $X_{i,\tau}$, and over time variation in rent, γ_1 and γ_2 can be separately identified as long as the variation of $g(\tau)$ over tenure is independent of the variation of Z_i, $X_{i,\tau}$. We state this formally in Lemma 1. The proof is straightforward.

Lemma 1: *If $\{r_{i0}g(\tau)\}_{\tau=1}^{T}$, any function of $\{X_{i,\tau}\}_{\tau=1}^{T}$ and Z_i are linearly independent, then the price coefficients γ_1, γ_2 are identified.*

Lemma 1 highlights the restriction imposed on the model specification that identifies the price coefficient, the per period utility of staying in an apartment is not a function of tenure. Hence, the only tenure dependency in per period utility is captured by the variation of rent. Next, we discuss identification of the term $c(X)$. Since in equation 8 $c(X)$ appears both in the denominator as well as numerator multiplicatively, it is clear that in the best case, it is identified up to a multiplicative constant. Given that, we can see that $c(X)$ can be identified from the over time variation of the term

$$r_i c(X_{i,\tau}) \times \frac{\sum_{l=1}^{T} \beta^l P(s > l,)[-\gamma_1 - \gamma_2 r_i(0) g(l)] g(l)}{\sum_{l=1}^{T} \beta^l P(s > l,) c(X_{i,l})}$$

This result is stated in the following Lemma, whose proof is, again straightforward.

Lemma 2: *$c(x)$ is identified up to a multiplicative constant. Lastly, we discuss the identification of the price equation $h(Z)$ and the utility function $b(Z, X, u)$. We now show that $h()$ is identified if $b_j(Z_i, X, u_{z,i})$ varies with X.*

Proposition: *Suppose that $h(Z)$ is the price equation term for Z and $b_{z_j}(Z_j, X_i, u_{z,i})$ defined as above is a nonconstant function of X and suppose that $u_z(Z, X)$ is a continuously differentiable function of Z and X. Then, among the class of functions $\tilde{b}_j(Z_i, X, \tilde{u}_z)$ with the same property, h is identified and b is identified up to a multiplicative constant.*

Proof Without loss of generality, assume that $h(0) = 0$, i.e. the function h does not include a constant. Consider the part of $\mu_{i\tau}$ which is a function of Z_i. Then, it is

$$\overline{\mu}_{i\tau} = [\sum_{l=1}^{T} \beta^l P(s > l, ..)[-\gamma_1 - \gamma_2 r_i(0)]g(l)]c(X_{i\tau})$$
$$\times \left[\frac{b(Z_i, X_{i\tau}, u_{zi})h_{zj}(Z_j)}{\sum_{l=1}^{T} \beta^\tau P(s > l,)b_{zj}(Z_i, X_{il}, u_{zi})c(X_{il})} - \frac{h(Z_j)}{\sum \beta^l P(s > l,)c(X_{il})} \right]$$

Since on the RHS, b and b_z appear in the numerator and the denominator, b is at best identified up to a multiplicative constant. Suppose there exists $\tilde{h}_j() \neq h_j()$, b_j,$\tilde{b}_j()$,u_{zi}, and $\tilde{u}_{zi}$, which gives the same $\overline{\mu}_{i\tau}$, i.e. such that

$$\frac{b(Z_i, X_{i\tau}, u_{zi})h_{zj}(Z_j)}{\sum_{l=1}^{T} W(l)b_{zj}(Z_i, X_{il}, u_{zi})} - \frac{h(Z_j)}{\sum_{l=1}^{T} W(l)} = \frac{\tilde{b}(Z_i, X_{i\tau}, \tilde{u}_{zi})\tilde{h}_{zj}(Z_j)}{\sum_{l=1}^{T} W(l)\tilde{b}_{zj}(Z_i, X_{il}, \tilde{u}_{zi})} - \frac{\tilde{h}(Z_j)}{\sum_{l=1}^{T} W(l)}$$

where $W(l) \equiv \beta^l P(s > l,)c(X_{il})$. Thus,

$$\frac{h(Z_j) - \tilde{h}(Z_j)}{\sum_{l=1}^{T} W(l)} = \frac{b(Z_i, X_{i\tau}, u_{zi})h_{zj}(Z_j)}{\sum_{l=1}^{T} W(l)b_{zj}(Z_i, X_{il}, u_{zi})} - \frac{\tilde{b}(Z_i, X_{i\tau}, \tilde{u}_{zi})\tilde{h}_{zj}(Z_j)}{\sum_{l=1}^{T} W(l)\tilde{b}_{zj}(Z_i, X_{il}, \tilde{u}_{zi})}$$

Then,

$$\frac{h(Z_j) - \tilde{h}(Z_j)}{\sum_{l=1}^{T} W(l)} = \frac{\sum_{l=1}^{T} W(l)[\tilde{b}_{zj}(Z_i, X_{il}, \tilde{u}_{zi})b(Z_i, X_{i\tau}, \tilde{u}_{zi})h_{zj}(Z_i) - b_{zj}(Z_i, X_{il}, \tilde{u}_{zi})\tilde{b}(Z_i, X_{i\tau}, \tilde{u}_{zi})\tilde{h}_{zj}(Z_i)]}{[\sum_{l=1}^{T} W(l)b_{zj}(Z_i, X_{il}, u_{zi})][\sum_{l=1}^{T} W(l)\tilde{b}_{zj}(Z_i, X_{il}, \tilde{u}_{zi})]}$$

Thus,

$$[\sum_{l=1}^{T} W(l)]\{\sum_{l=1}^{T} W(l)[\tilde{b}_{zj}(l)b(\tau)h_{zj} - b_{zj}(l)\tilde{b}(\tau)\tilde{h}_{zj}]\}$$
$$= [\sum_{l=1}^{T} W(l)b_{zj}(l)][\sum_{l=1}^{T} W(l)\tilde{b}_{zj}(l)][h(Z_j) - \tilde{h}(Z_j)]$$

Now, let X_{i1},...,X_{iT} be such that

$$u_{zi}(Z_i, X_i) = \overline{u}_{zi}, \widetilde{u}_{zi}(Z_i, X_i) = \overline{\widetilde{u}}_{zi}$$

That is, X_i can vary given that u_{zi}, $\widetilde{u}_{zi}$ remains constant. Now, if we compare each term involving $X_{il}, X_{ik}, l \neq k, l \neq \tau, k \neq \tau$, then

$$\begin{aligned} W_l W_k [\tilde{b}_{zj}(l) b(\tau) h_{zj} - b_{zj}(l) \tilde{b}(\tau) \tilde{h}_{zj} + \tilde{b}_{zj}(k) b(\tau) h_{zj} - b_{zj}(k) \tilde{b}(\tau) \tilde{h}_{zj}] \\ = 2 W_l W_k b_{zj}(l) \tilde{b}_{zj}(k) [h(Z_j) - \tilde{h}(Z_j)] \end{aligned}$$

Since the LHS term contains $b_{zj}(\tau)$, which is a function of $X_{i\tau}$ whereas the RHS term does not, and the RHS contains the cross term $b_{zj}(k) b_{zj}(l)$ but the LHS does not. In order for the above equality to hold for any X_i given z, b_{zj} cannot be a function of X, which contradicts the assumption and prove the proposition.

Lemma 1, 2 and the proposition summarize the identification of the model. For the identification to work, we need the elasticity of substitution between observable and unobservable housing characteristics to be a function of observable individual characteristics. This is similar to the standard hedonic literature, which assumes that the marginal rate of substitution between observed housing characteristics Z_i and other consumption goods C_i is a function of individual observed characteristics $X_{i\tau}$. The restriction used in the above identification strategy is that the rental market is competitive. That is, the individual observed characteristics enter in the marginal rate of substitution between Z_i and v_i, but not in the rent equation.

The parameters are estimated on the mobility data. That is, parameters are chosen so that the generated unobserved heterogeneity results in per period utility that explains best the pattern of mobility. That is, parameters should be chosen such that individuals who stayed longer in an apartment have higher per period utility. If we can assume that the unobserved characteristics v_i are orthogonal to the observed ones, Z_i, then, similarly to the standard hedonic literature, we can identify most of the parameters of the hedonic model without duration data, using the static hedonic model. To see this, first consider the rent equation. With the additional orthogonality condition, we can obtain the function $h(Z)$ of the rent equation just by OLS. Then, if we modify equation

(1.3) and add another term $b_x X_i$, it becomes

$$r_v b_Z(Z_i, X_i) u_{zi} + r_v b_x X_i = h'(Z_i) \tag{1.7}$$

This setup is very similar to that of Ekeland, Heckman, and Nesheim (2004) and Heckman, Matzkin, and Nesheim (2009) and other hedonic literature, where the authors show identification of the parameters of the function $r_v b_Z$ given that the utility shock u_{zi} is independent of X_i, and given some functional form assumptions. It is of some interest that in static hedonic model, one can only identify the utility function parameters well if the marginal utility function is fully flexible. One common restriction is that it is linearly separable in Z_i and X_i. However, we have shown that in dynamic hedonic models, the utility function component $b(Z_i, X_{i,\tau})$ can be made more flexible. In sum, both the hedonic optimal choice part and the dynamic discrete mobility choice part complement each other in identifying the structural parameters and the unobserved heterogeneity of each individual.

1.4 Estimation

We estimate the model by maximum likelihood. The likelihood function is set up as follows. The likelihood increment for individual i who has been living in an apartment for τ years and whose mobility decision is $I_{m,i}$, is

$$L_i = [\prod_{l=1}^{\tau}(1 - P_m(l, X_i, Z_i))][I_{m,i} P_m(\tau + 1, X_i, Z_i) + (1 - I_{m,i})(1 - P_m(\tau + 1, X_i, Z_i))]$$

where the mobility probability is defined as in equation 2. The likelihood is the product of individual likelihood increments, i.e.

$$L = \prod_{i=1}^{N} L_i$$

We set the parameters of the rental price equation as follows:

$$h(Z_i) = r_{z1} Z_{1i} + r_{z2} Z_{2i} \tag{1.8}$$

where Z_1 is composed of the number of rooms, the mean floor area per room and a dummy indicating whether or not the housing unit has two bathrooms. These three variables are supposed to capture the size and the observed quality of a housing unit. According to the urban economic theory, another important determinant of a housing unit price is its location in the city. That is, individuals make a tradeoff between living in the center of the city (paying a high rent) and far away from the center (paying commuting cost). As a consequence, a rent curve can be derived that predicts that the price is decreasing with distance to the city center. Thus, Z_2 is composed of the distance to the center and the population of the city. Hence, the population captures the constant associated to the rent curve, while the distance seizes the slope of the curve.

The parameters of the components of the per period utility function for staying in the apartment are specified as follows

$$b(Z, X) = u_{Z,i} Z_i + \frac{1}{2} Z' b_2 Z + X b_X Z \tag{1.9}$$

and we normalize one element of the vector $u_{Z,i}$ to be 1, and, as discussed before b_1 is normalized to 1.

Furthermore, we specify the effect of individual attributes to be

$$c(X) = c_1 + c_x X$$

where we also normalize c_1 to be 1. The utility of moving out is specified as

$$\varphi_0 + \varphi_1 log(X_i)$$

The derivation of the likelihood increment for each individual i requires the computation of individual specific unobserved utility components $u_{v,i}$, $u_{Z,i}$ and u_i. Equations (1.4) and (1.5) which show the relationship between $u_{v,i}$, $u_{Z,i}$, u_i and the mobility probability and other variables and parametersalso describe the fixed point that $u_{v,i}$, $u_{Z,i}$ and u_i need to satisfy. Hence, we compute the unobserved utility components using the following iterative algorithm.

Step 1 Given $u_{v,i}$, $u_{Z,i}$, u_i, derive the choice probability, and thus $P(s > l)$ for each l.

Step 2 Given $P(s > l)$, derive the next iteration $u'_{v,i}$,$u'_{Z,i}$, u'_i using equations (1.4) and (1.5).

We stop the above iteration if

$$\left\| \begin{array}{c} u_{v,i} - u'_{v,i} \\ u_{Z,i} - u'_{Z,i} \\ u_i - u'_i \end{array} \right\| < \delta \tag{1.10}$$

Where δ is a stopping criterion close to 0. We next show that there indeed exist $u_{v,i}$, $u_{z,i}$, u_i that satisfy equations (1.4) and (1.5). Since $P()$'s on the RHS in these equations are also functions of $u_{v,i}$ and u_i, equations (1.4) and (1.5) describe the fixed point of the mapping.

$$u'_{v,i} = \frac{\sum_{\tau=1}^{T} \beta^{\tau} P(s > \tau, u_{v,i}, u_i) b_{Z_J}(Z_i, X_{i\tau}, u_{Z,i}) c(X_{i,\tau})}{\sum_{\tau=1}^{T} \beta^{\tau} P(s > \tau, u_{v,i}, u_i) c(X_{i,\tau}) h_{Z_J}(Z_i)} \tag{1.11}$$

$$u'_i = -\frac{h_{Z_J}(Z) \sum_{l=1}^{T} \beta^{l} P(s > l, u_{v,i}, u_i)[\gamma_1 + \gamma_2 r_i(0) g(l)] g(l)}{\sum_{l=1}^{T} \beta^{l} P(s > l, u_{v,i}, u_i) b_{Z_J}(Z_i, X_{i\tau}, u_{Z,i}) c(X_{i,l})} \tag{1.12}$$

Notice that since the first element of u_{Z_J} is set to zero by normalization, the above functional form setup implies

$$b_{Z_J}(Z_i, X_{i\tau}, u_{Z,i}) = b_{Z_J}(Z_i, X_{i\tau}, 0)$$

Now, let

$$\overline{u}_v = argsup_{u_v,u} \frac{\sum_{\tau=1}^{T} \beta^\tau P(s > \tau, u_v, u) b_{Z_J}(Z_i, X_{i\tau}, 0) c(X_{i,\tau}}{\sum_{\tau=1}^{T} \beta^\tau P(s > \tau, u_v, u) c(X_{i,\tau}) h_{Z_J}(Z_i)} \tag{1.13}$$

and define $\underline{u}_v$ similarly as the arginf of u_v. Define $\overline{u}$ and $\underline{u}$ similarly as well. If we assume that both the numerator and denominator of equations (1.4) and (1.5) to be bounded from above and below from 0, then both $\underline{u}_v$, $\overline{u}_v$, and $\underline{u}$, $\overline{u}$ are all bounded below by zero and bounded above. Thus, the rectangular space defined by

$$\mathcal{U} \equiv \{(u, u_v) : \underline{u} \leq u \leq \overline{u}, \underline{u}_v \leq u_v \leq \overline{u}_v\}$$

is compact and convex. Since the function mapping $(u, u_v) \in \mathcal{U}$ to $(u', u'_v) \in \mathcal{U}$ is well defined and continuous, it satisfies all the conditions for the Brouwer's Fixed Point theorem. Therefore, there exists a fixed point $(u, u_v) \in \mathcal{U}$ that satisfies equations (1.4) and (1.3).

1.5 Estimation Results

In Table 1.2, we report the Maximum likelihood estimation results of the basic model. All thestructural parameters have the expected sign. The price coefficients γ_1, for the per period utility of staying is negative and significant. The square price coefficient γ_2 is negative and significant. The coefficient of the squared term of the number of rooms, and mean size per room are positive and significant indicating that higher number of rooms, and bigger rooms yield a higher utility. Moreover, the coefficient of the dummy for two bathrooms is positive and significant but of lower magnitude than the number of rooms. The coefficient that measures the interaction between age and number or rooms in the utility function is negative, implying that marginal utility of number of rooms is increasing with age that is consistent with the life-cycle theory of housing demand. The coefficients of the utility of moving out are both significant. The coefficient of log age is negative, which reflects the data where older people move less often.

Finally, the coefficients in the rent equation are one would have expected.In monetary amount, the model states that one needs 121 € for an additional room, and 111 € for 10 m^2 of additional floor area while a second bathrooms cost 303 €. In terms of rent curve, the model implies a price increase of 47 € for additional 100,000 inhabitants while the rent decreases of 21 € for each additional kilometre . These parameters are in contrast with the very simple version of the typical price equation estimated in the hedonic literature. We can see that the OLS estimated coefficients are much lower, from about 20% to 90% of the value of the coefficient estimated by ML. The ML and OLS results imply that the unobserved housing specific heterogeneity is negatively correlated with the observed characteristics included in this estimation.

Table 1.2: Parameter Estimates and Standard Errors

	Parameters	Est.	S.E.
Utility	Age	-0.361*	0.22
	Number of rooms	1.824***	0.28
	Mean size per room	0.292*	0.17
	Dummy for two bathrooms	0.351***	0.10
	Price in the center	0.117	0.08
	Distance to the center	-0.678***	0.04
	γ_1	-0.268***	0.11
	γ_2	-0.001	0.002
Interactions	Age $\times$ # of rooms	-2.993*	1.56
	Age $\times$ Mean size per room	-0.442	0.96
	Age $\times$ Dummy for two bathrooms	0.276	0.34
	Age $\times$ Price in the center	-0.303	0.22
	Age $\times$ Distance to the center	0.440***	0.16
Rent	Number of rooms	1.208***	0.47
	Mean size per room	1.118**	0.51
	Dummy for two bathrooms	3.032***	0.36
	Price in the center	0.473***	0.21
	Distance to the center	-0.217*	0.11
	φ_0	-1.935***	0.51
	φ_1	-0.209***	0.07

***, ** et * indicate significance at the 1%, 5% et 10% level

Table 1.3: OLS

Parameters	Parameters	S.E.
Const	1.11***	0.13
Number of rooms	0.99***	0.02
Mean size per room	0.70***	0.04
Dummy for two bathrooms	2.12***	0.11
Price in the center	0.22***	0.06
Distance to the center	-0.03***	0.002

***, ** and * indicate significance at the 1%, 5% et 10% level

Finally, we report our estimated utility shocks and unobserved heterogeneity.

1.6 Conclusion

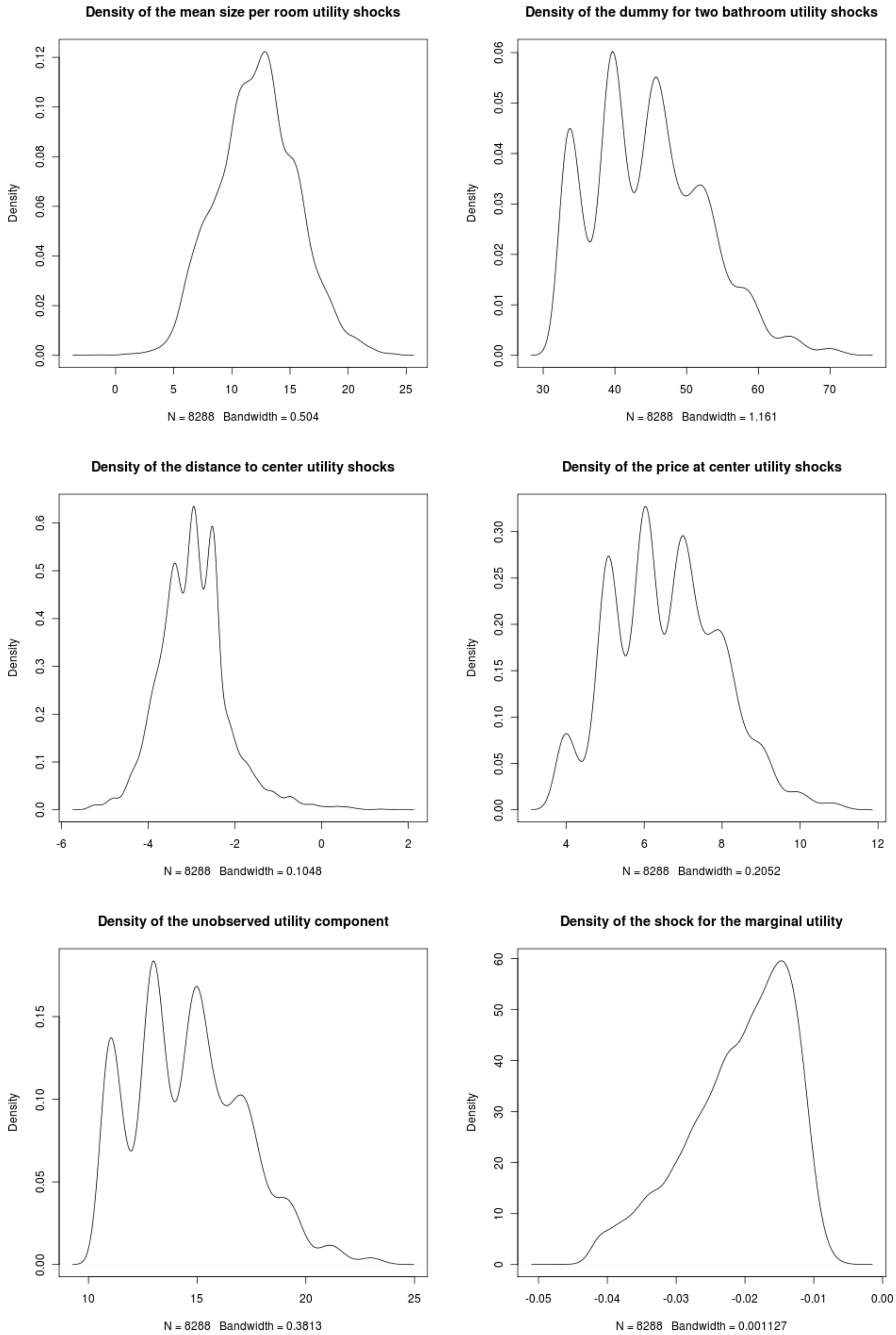
In this essay, we propose to estimate the parameters of the price equation and the structural hedonic model by utilizing the tenure and mobility data of rental apartments in France. We used the French data on rental apartments, because it has the detailed information on tenure, i.e. length of stay in an apartmentand mobility, in addition to the detailed information on the characteristics of the apartment and the renter. The additional benefit of the data on French apartments are that in France, the rent is regulated to grow at a low mandated rate, which is not related to the local housing market. Therefore, we do not need to worry about the endogeneity of the price of rent when we use the over time variation of rent for identification of the price coefficient. The literature has estimated dynamic models of housing choice, and also estimated the duration models on the tenure choice, but so far it has not explicitly used the duration data to identify the parameters of the hedonic model.

It turns out that the coefficients of the observed housing characteristics areidentified without the restriction that the observed and unobserved characteristics are orthogonal, the assumption that is often used in estimating the hedonic model. Furthermore, marginal utility of observed characteristics can be a flexible function of observed housing and individual characteristics. This is in contrast to the conventional identification and estimation strategy of hedonic models, where marginal utility needs to be a separable function of observed housing characteristics and the characteristics of the consumer

The estimation results demonstrate that the observed and unobserved housing characteristics are negatively correlated, which is reasonable, since what we in general see in France is that in expensive neighborhoods, renters live in apartments with lower observed quality to make up for the high unobserved qualities of the neighborhood. Failure to take into account the endogeneity bias could underestimate the true value of the observed characteristics of housing.

An interesting direction for future research would be to extend the analysis of hedonic dynamic model to explicitly include neighborhood effects. There has been much interest in estimating the neighborhood effects in the static and dynamic hedonic literature. However, since neighborhood unobserved heterogeneity is also part of unobserved heterogeneity of a housing unit, we believe that the proper identification of it can be only done as an extension of the identification and estimation of the individual unobserved housing characteristics. This extension is left for future research.

Figure 1.2: Distributions of utility shocks



Essay 2

Equilibrium Effects of Local Tax Holiday Policies in the Presence of Search and Spatial Frictions

Introduction

Over the eighties, the unemployment rate in France rose sharply. This increase was particularly impressive in a category of neighborhoods located in the inner cities referred to as *banlieues*. Several causes exist to the high level of unemployment in the *banlieues* such as inadequate qualification or discrimination.[1] However, the hypothesis of spatial mismatch seems credible to the government because of the disconnection between the banlieues and the job centers. This problem was exacerbated by the lack of public services, more specially, public transit.

In 1996, the French government launched a large scale Enterprise Zones policy which takes the form of a territorial positive action towards banlieues including a labeling into *Zones Urbaines Sensibles* (ZUS), *Zones de Redynamisation Urbaine* (ZRU) and *Zones*

[1] Back to the seventies, these locations had been the favorite implantation of large public housing projects because of the low land prices. As a consequence, the former locations had host the majority of incoming immigrants, and individuals with low income.

Franches Urbaines (ZFU). Here I pay attention to the Enterprise Zones policy hereafter FEZ or ZFU designed to offers tax breaks to the companies who create a production unit in these locations.

Fifteen years after the introduction of the policy, its effectiveness need to be assessed. Over the period from 1995 and 2008 the net attractiveness of the locations subject to the policy was about 24.4 to be compared to 6.4 for locations not subject to the policy.[2] As a consequence, the stock of firms located in ZFUs doubled from about 26,000 to 52,000. Meanwhile, following the path of the business cycle, the unemployment rate decreased by 20.6 % in ZFUs while it was decreasing by 27.7 % in the rest of France. These observations suggest an effectiveness in terms of firms attraction that has not translated into a lower unemployment rate. As a consequence, one can assume that the mechanism in play may be far more complex than spatial mismatch.

This essay contributes to the evaluation of tax holiday policies, but starts with the idea that the labor market is characterized by considerable frictions (Mortensen and Pissarides, 1999; Rogerson and Shimer, 2011). The existence of frictions may shape our understanding of programs like the French Enterprise Zones.

The existing evaluations of the policy have focused on the growth of the number of firms by using quasi experimental methods (Rathelot and Sillard, 2007), and the hazard rate out of unemployment (Gobillon, Magnac, and Selod, 2007). They both reported a slightly positive effect of the ZFU policy.

However, the standard policy evaluation literature may not be the right framework to analyze the policy since it assumes that individuals not treated by the program would have the same outcome as non-participants if the program was implemented more widely. Several pieces of evidence suggest the violation of the former assumption.

In the case of the French Enterprise Zones, it is unrealistic to assume that the agents will not modify their behavior following a change in the behavior of firms. Indeed, in the most basic setup, inhabitants of the treated areas may modify their reservation wage to account for the decrease in commuting cost induced by the relocation of firms. Thus, a

[2] I define the net attractiveness as the ratio between implantation and stock.

general equilibrium effect may exist and modify the wage distribution. As a consequence, the fundamental assumption of the standard policy evaluation is violated. Moreover, as we will see later, a comparison between a treated and a non-treated locations may provide useless outcomes because of the high level of residential mobility observed in the treated locations after the policy introduction.

Model-based policy evaluations have been popular recently in equilibrium search theory. Mortensen and Pissarides (2001) consider a variety of tax policies in equilibrium search theory. Others examples include Van der Linden (2005) or Cahuc and Le Barbanchon (2010) who proposed equilibrium search models for policy evaluation purpose. However, these models have been calibrated following the macroeconomic literature and calibration is an effective tool prior to policy introduction. In this case, I can rely on individual data to estimate the effects of the policy. Following this intuition, Lise, Seitz, and Smith (2003) develop and estimate a search model to analyze the effects of the Canadian Self-Sufficiency project. In the first part, they estimate a partial equilibrium model of job search. The obtained parameters are combined with calibrated parameters to assess the potential general equilibrium effects of a large scale introduction of the Canadian Self-Sufficiency Project. I extent into that direction while carrying full estimation and adapt it to the French Enterprise Zones.

The existing estimated equilibrium search models use the stationary unemployment rate to infer about individual probability to be unemployed (van den Berg and Ridder, 1998; Postel-Vinay and Robin, 2002).[3] However, as noted by Wasmer and Zenou (2004) these models are designed as spaceless markets even in presence of clear evidence of impacts of space on labor market outcomes.

As a consequence, a large body of literature has tried to include space into job search models modeling jointly spatial and search frictions. Coulson, Laing, and Wang (2001) have been the first to use a theoretical model to generate differential of unemployment

[3]The first estimated equilibrium search model is due to Eckstein and Wolpin (1995), a survey of the literature is presented by Eckstein and van den Berg (2007). Current trends in the literature extend the search equilibrium to allow for experience accumulation (Adda et al., 2010), and account for the effect policy intervention

rate across locations as stated by the spatial mismatch hypothesis. Their underlining assumption is that some individuals are willing to accept longer commuting. They also consider heterogeneity in firms entry cost between locations. The main drawback of such an approach is that the spatial distortion is moved to the firm's side. Several other papers attempted to produce unemployment rate differentials using several features: search effort (Smith and Zenou, 2003) and low matching rate due to the distance between residential and working location (Wasmer and Zenou, 2004). Another example includes Brueckner and Zenou (2003) who assume discrimination that prevent blacks to settle in the suburbs regardless of their willingness to pay. Then, they analyze its effect on wage and unemployment.

This literature concludes that when spatial mismatch is modeled within an equilibrium job search theory, it provides a powerful tool to understand the dynamic of search in presence of commuting between locations, and hence the dynamic of unemployment across locations.

I build upon Mortensen (1998), Bontemps, Robin, and Van den Berg (1999) and Wasmer and Zenou (2004). Thus, my model contributes to the empirical equilibrium search literature by implementing a wage posting model with an accurate representation of the FEZ policy. As in Bontemps, Robin, and van den Berg (1998), I allow for heterogeneity in the productivity of firms. I borrow the spatial structure of Wasmer and Zenou (2004) even though this model is less rich for the sake of the future estimation. And following Mortensen (1998), I endogeneize job offer rate as a function of the market aggregate and the physical distance between the location of firms and individuals. Finally, both individuals and firms are allowed to move as a response to the policy.

In contrast to the usual controlled experiments, the FEZ policy was designed for firms. Even though the ultimate goal was to modify individual prospects on the labor market, it seems inconceivable to evaluate the individual behavior without paying attention to firms' response to the policy. Hence, I develop a firm location choice model that allows me to recover the distribution of firms' productivity across locations. Thus, I am able to analyze the impact of the policy on the location of firms.

I take this model into estimation using a hierarchical Bayesian MCMC, flexibly allowing for location fixed effects both on the firm and individual side. This literature draws its data from the French Labor Survey from 2003 to 2008. The major feature of the data is that it allows to locate individuals at the finest geographical level. In addition, I use an administrative database that keeps tracks of firms located in ZUS and ZFUs since the policy introduction.

The rest of this essay is organized as follows. In the first section, I present the policy, in the second, the behavioral model. The third is devoted to the presentation of the data and the estimation strategy. Finally, I present the results and a decomposition of the job offer rate.

2.1 The French Enterprise Zones Policy

After the second world war, and following the 1954 hard winter, the French government invested massively in public housing units. In order to reduce the cost of land, and in need for large amount of available land, the majority of public housing was built into the inner suburbs. The inner suburbs, like any suburbs, were disconnected from the center of the cities. Thereafter the public housing unit will host incoming immigrants and low income households. Later, the mix of race, poverty and the lack of public transit contributed to rising segregation that the government tried to tackle as soon as the early eighties. In the aftermath of the 1979 energy crisis, the national unemployment rate rose from 4% in 1979 to 9% in 1986. This increase in unemployment deepened the disparities between neighborhoods.

According to the 1990 census, the inhabitants of the inner suburbs experienced a higher level of unemployment with more than 20% instead of less than 10% in the rest of the country. Moreover, the proportion of households below poverty line was high: 26.5% instead of 9% in the rest of the country.

The French government passed in 1991 a bill empowering the local authorities to take the needed steps in the housing market to create an effective "social mixity".[4] Besides the law suggested to take measures in order to help businesses create more production units into the banlieues, to improve the quality of public transit, and to guarantee the safety of individuals.

In 1996, the government decided that the 1991 bill was surpassed by the magnitude of the segregation and that additional steps were required. The general goal was to overcome segregation on two fronts: first, by attracting more working-class families into the neighborhoods in order to change the social composition; second, by attracting more businesses into these neighborhoods and then overcome the potential spatial mismatch. The government instituted a territorial discrimination policy that provides fiscal incentives to firms that were or will be located into these areas. Prior to the policy introduction, an index of socio-demographic difficulties was created, based on

- The population of the area
- The proportion of young people (less than 25 years old)
- The unemployment level
- The proportion of unskilled workers
- The municipality fiscal potential

The government created 751 sensitive urban zones (ZUS) after consultations with local authorities. Among these ZUS, the 416 neighborhoods with the highest value of the index are identified to face particular difficulties and are promoted urban renewal zones (ZRU). Finally, 44 areas with the highest value of index, and hence the worst conditions were promoted Free Urban Areas (FEZs for French Enterprise Zones in the following). They constitute the first generation of ZFUs. In 2004, 41 second generation ZFUs were set up. Finally in 2006, a third generation of ZFUs was created that complete to 100 the

[4] The law of city orientation was voted in 1991, very little is known about its application and effectiveness.

total number of ZFUs. The fiscal advantages induced by the policy are summarized in Table 2.1.

The cost originally estimated to 120 millions € has increased to 360 millions € in 2001 before reaching more than 570 millions € in 2006. In front of these huge costs, the question arises how the policy affected individuals' and firms' behavior. In this essay, I will try to shed new light on the effect of the policy.

Table 2.1: Policy Description

Tax	Definition	ZRU	ZFU
Local business tax	3.5 % of the physical asset	Firms with a taxable amount lower than€125,198. Full exemption during the first two years, then 75 %, 50 % and 25 % the following three years	Firms with a taxable amount lower than €337,713. then 60 % the following three years, 40 % the additional three years and 20 % the following three years
Corporate taxes	33.3 % of the profit	Firms with a taxable amount lower than €225,000 on a 3 years period. Full exemption during the first years, then 60 % the following three years, 40 % the additional three years and 20 % the following three years	Firms with a taxable amount lower than €100,000 + €5,000 for each new hired employee. Full exemption during the first five years, then 60 % the following three years, 40 % the additional three years and 20 % the following three years
Payroll taxes	40 % of the gross wage paid by the firm	Only for firms with less than 50 employees, and inapplicable for workers who earn more than 1.5 times the minimum wage. Full exemption during the first two years, then 75 %, 50 % and 25 % the following three years	Only for firms with less than 50 salaries, and inapplicable for workers who earn more than 1.4 times the minimum wage. Full exemption during the first years, then 60 % the following three years, 40 % the additional three years and 20 % the following three years
Property taxes			Full exemption during the first five years

2.2 Labor market setup

In this section I describe the behavioral model used to study the impact of the FEZ policy. The model is formulated in discrete time, and I assume stationarity. Space is continuous and individuals are allowed to migrate and commute.

2.2.1 Workers strategy and space configuration

I consider a continuum of local labor markets indexed by $l = 1 \ldots L$. Each local labor market corresponds to a metropolitan area. A local labor market consists of a central location denoted A, and of an inner suburb denoted Z that is subject to the policy. When located in l_1, I denote by C the other locations l_{-1}. In order to keep the model tractable and realistic, I assume that an individual cannot live and work into different markets, but inside a market, agents can live and work in different locations. In what follows, I suppress l from of the notations, because every metropolitan area is treated as a separate market and data across markets are not pooled together in the estimation.

I consider a market in which a measure $m = m^A + m^Z$ of agents faces a measure of firms $n = n^A + n^Z$. Agents maximize the utility flow over the life-cycle, approximated by the expected steady state future income discounted at exogenous and constant rate β. When working and living locations differ, individuals have to incur a commuting cost θ, that I will describe in detail later.

Agents may be either employed or unemployed, and these states are indexed by **e**, and **u**. Unemployed agents receive an unemployment benefit b. Job destruction is nationwide at rate δ. When unemployed, job offers accrue at rate λ_u. On the job search is allowed and the arrival rate of offers to on-the-job searchers is λ_e.

Workers differ with respect to their observed skill level. The labor market is segmented allowing for a specific unemployment equilibrium for each skill specific sub-market. I face a trade-off regarding the total number of skill levels to include in the model. A high number of skill category will be subject to finite sample issue, while a small number may pool together individuals who do not belong to the same sub-market.

In the empirical section, I will present the specification for the number of individual types. I assume for now that there are $\mathcal{K}$ types of individuals in the population.

I can now move on to the dynamics of employment across locations. The job offer rate estimated by the model is the rate at which vacancies are filled. In the absence of spatial frictions, one would have expected the unemployment rate to be similar across locations. However, there is a clear difference between unemployment rates in city centers and inner suburbs.

I model several channels allowing for such a situation. First, I assume that there are agglomeration externalities on the firm's side, that result in a difference between the total number and the mean productivity of firms located in A and Z. Furthermore, I posit that there are informational and search frictions resulting in a lower job arrival rate when the firm and individual locations differ. This effect is strengthened by the difference in the number of firms in each location.

Assumption Job offers can accrue from firms located in A, Z and from other local labor markets C. The job offers rate for inhabitants in A can be written

$$\lambda^A = \lambda^{AA} + \lambda^{ZA} + \lambda^{CA} \tag{2.1}$$

where λ^{AA}, λ^{ZA} and λ^{CA} are respectively the job offers from firms located in A, Z and C toward workers living in A.

For the policy evaluation purpose, the job offer rate has to be somewhat endogenous in the model. I leave until the next section the analysis of the job arrival rate when the reader will be familiar with the strategy of firms.

Assumption In order to commute from location A to Z, individuals must incur a fixed cost ψ_0, and a variable cost that is function of the distance between job and home location $\psi(d)$. The location Z is considered small enough to set $\psi_{ZZ} = 0$, while $\psi_{AA}(d) = \psi(d)$.

Finally, the effective commuting cost is:

$$\psi_{AZ}(d) = \psi_{ZA}(d) = \psi_0 + \psi(d) \tag{2.2}$$

The rationale for this assumption is the existence of a toll ψ_0 between locations A and Z. Location Z is small enough to generate no mobility cost.

I adopt the convention that $F(w)$ denotes the probability that a wage offer is smaller or equal to w. As a consequence, workers sample a wage from the distribution F which has support $[\underline{w}, \overline{w}]$. I assume that $\underline{w}$ is the minimum wage, and define $\bar{F} \equiv 1 - F$.

In this framework, firms are not allowed to discriminate among workers depending on their location. However, it will be clear from the next section, that the wage offer distributions are to be different across locations because of the truncation in productivity between firms in A and Z induced by the policy. I denote by $F^A(w)$ and $F^Z(w)$ the wage offers of firms in A, and Z. In line with the same reasoning, but also because of the transit cost, there must be a difference between the earning distributions $G^A(w)$ and $G^Z(w)$ will be different.

Finally, individuals are allowed to migrate. As we will see later, the data does not allow me to follow individuals over locations. Then, the motives for moving and the subsequent employment spells are not known. I do not make any assumption about the motives nor about the subsequent spell. However, I model individual decision in such a way that I can recover a neighborhood fixed effect.

Assumption I denote γ^{ij} the residential mobility rate location i to j.

2.2.2 Firm strategy

In this subsection, I introduce the behavior of firms in order to have an equilibrium model. As in Burdett and Mortensen (1998), I assume a wage posting strategy. Firms are exogenous with regard to the sector in which they operate and they compete for skill-specific agents. Agents of different types are not substitutable. Each firm operates a technology function with a specific skill requirement. Firms differ in their exogenously determined productivity q. The cumulative distribution of firm productivity is denoted by Γ which is continuous on its support $[\underline{q}, \overline{q}]$.

The central issue is how to capture at the same time the initial repartition of firms and the mobility behavior in some sectors. Suppose the productivity level q can be decomposed into a firm specific component p and a location specific component μ.

The economic content of μ can be summarized as follows: when a large number of firms is located into an area, it will generate a high value of μ and attract more firms. As a consequence, μ can be thought of an agglomeration effect, but also an index of development lowering firms' entry cost.

The static profit function is given by:

$$\pi(w, t_c, t_p, t_b) = [1 - t_c] \sum_{\mathcal{K}} [p_k + \mu - [1 + t_p] w_k] l_k(w_k) - [1 + t_b] c(p, \mu) \tag{2.3}$$

Where t_c, t_p and t_b are the corporate, payroll and business tax rates. $c(p, \mu)$ is a function that approximates the amount of capital needed by the firm to have a productivity p and to benefit from μ. [5] $l_k(w)$ defines the number of type k workers, a firm can expect to hire by offering a wage w. I assume that the firm-specific productivity component is fixed over time, but the p_k differ across $\mathcal{K}$. The policy operates as follows, for the firms located in Z, the taxation rates can be set to 0 under some constraints. In order to be eligible to the policy, a firm must have less than 50 employees. Then, for the other taxes cuts, the amount is capped. These conditions are summarized in the next equations.

[5] This expression is introduced to bound the demand for μ.

$$
\begin{aligned}
& l \leq 50 \\
& w \leq 1.4 \cdot \underline{w} \\
& \frac{1}{3} \cdot \tilde{\pi} \leq 100,000 \\
& 0.03 \cdot c(p, \mu) \leq s_r
\end{aligned}
$$

Prior to the policy introduction, the firm problem was to choose the level of wage, w and μ that maximize its profit. The policy introduces a distortion, that is, in the region of the policy constraint parameters, firms may find it more profitable to bind the policy constraints instead of maximizing their profit.

A likely situation is that for some types of individuals, the following relation holds: $w_k > 1.4\underline{w}$. As a consequence, the policy will by design rule out the highest productivity and the biggest firms.

2.2.3 Matching and equilibrium

I now endogenize the job arrival rate. A firm that has not reached its optimal size l^* opens up a vacancy and post a wage. All the wage offers are processed into a matching function and the job offer rates are derived. The job offer rate from firms in j towards workers in i is defined as follows

$$\lambda^{ji} = M(U^j, U^i, N^j, N^i, \psi_{ij}) \tag{2.4}$$

where ψ_{ij} summarizes the spatial and information frictions between i and j. I assume here that the job arrival rate depends on the tension in the market, the number of firms, and the spatial frictions. One can expect the following relationships to hold

$$\frac{\partial \lambda^{ij}}{\partial U} < 0$$

$$\frac{\partial \lambda^{ij}}{\partial N} > 0$$

$$\frac{\partial \lambda^{ij}}{\partial \psi_{ij}} < 0$$

2.2.3.1 Individual choices

Before moving to the labor market dynamics, I focus on the reservation wage strategy. In the standard job search theory, the reservation wage equalizes the values of employment and unemployment. What I need to emphasize more is the trade-off between jobs located at different distances from the individual's residential location. The choice is not only based on the wage offer, but also on the transit cost. I define $r(w)$ as the indifference wage that makes an individual living in A and working for the wage w, indifferent between accepting a job in A at distance d and a job located in Z at distance d':

$$w - \psi(d) = r(w) - \psi_0 - \psi(d') \tag{2.5}$$

This relationship describes the link between the wages an individual may accept across locations.

Several features of the model need to be pointed out to be able to write the unemployment equilibrium. The timing is important to understand the next equations. At each period, an individual decides whether to move or not. Independently of the mobility decision, she may receive a job offer from other locations. I consider the outcomes of the labor market at the steady state. I evaluate the equilibrium just after the potential mobility. At this time, mobile individuals have not yet received any job offer at the same rate as the inhabitants of their destination.

I evaluate equilibrium at the level of the local labor market, and derive equilibrium for each location. I suppose that the population is stationary. Hence, the following equality holds:

$$\begin{aligned} m = m^A + m^B &= \underbrace{(1-\gamma^{AC}-\gamma^{AZ})m^A + \gamma^{ZA}m^Z + \gamma^{CA}m^C}_{\text{Population in A}} \\ &+ \underbrace{(1-\gamma^{ZC}-\gamma^{ZA})m^Z + \gamma^{AZ}m^A + \gamma^{CZ}m^C}_{\text{Population in Z}} \\ &= (1-\gamma^{AC})m^A + \gamma^{CA}m^C + (1-\gamma^{ZC})m^Z + \gamma^{CZ}m^C \end{aligned}$$

Assume now that the unemployment rate is stationary in the labor market:

$$u = u^A + u^Z = \underbrace{(1-\gamma^{AC})(1-\lambda_u^{AA}-\lambda_u^{ZA})u^A + \delta(1-\gamma^{AC})(m^A-u^A)}_{\text{Non mobile unemployed in A}}$$

$$+ \underbrace{(1-\gamma^{ZC})(1-\lambda_u^{AZ}-\lambda_u^{ZZ})u^Z + \delta(1-\gamma^{ZC})(m^Z-u^Z)}_{\text{Non mobile unemployed in Z}}$$

$$+ \underbrace{\gamma^{CA}\left[(1-\lambda_u^{AC})u^C + \delta(m^C-u^C)\right] + \gamma^{CZ}\left[(1-\lambda_u^{ZC})u^C + \delta(m^C-u^C)\right]}_{\text{Flow of new unemployed after mobility}}$$

Rearranging the equation 2.6 yields:

$$\begin{aligned} u^A\Big[1-(1-\gamma^{AC})\left[1-\lambda_u^{AA}-\lambda_u^{ZA}+\delta\right]\Big] &= u^Z\Big[(1-\gamma^{ZC})\left[1-\lambda_u^{ZZ}-\lambda_u^{AZ}-\delta\right]-1\Big] \\ &+\delta\bigg[\Big[(1-\gamma^{CA})m^A + \gamma^{AC}m^C\Big] + \Big[(1-\gamma^{CZ})m^Z + \gamma^{ZC}m^C\Big]\bigg] \\ &+u^C\Big[\gamma^{CA}(1-\lambda_u^{AC}) + \gamma^{CZ}(1-\lambda_u^{ZC}) - \delta(\gamma^{CA}+\gamma^{CZ})\Big] \end{aligned}$$

In equation (2.6), both m^A and m^Z can be replaced by their corresponding expressions.

After few steps of algebra, I can derive the unemployment rates in location A and Z.

$$\begin{aligned}
\frac{u^A}{m^A} &= \frac{\delta}{\Big[1-(1-\gamma^{AC})\big[1-\lambda_u^{AA}-\lambda_u^{ZA}+\delta\big]\Big]} \\
&+ \frac{\delta m^Z + u^Z\Big[(1-\gamma^{ZC})\big[1-\lambda_u^{ZZ}-\lambda_u^{AA}+\delta\big]-1\Big]}{m^A\Big[1-(1-\gamma^{AC})\big[1-\lambda_u^{AA}-\lambda_u^{ZA}+\delta\big]\Big]} \\
&+ \frac{u^C\Big[\gamma^{CA}(1-\lambda_u^{AC})+\gamma^{CZ}(1-\lambda_u^{ZC})-\delta(\gamma^{CA}+\gamma^{CZ})\Big]}{m^A\Big[1-(1-\gamma^{AC})\big[1-\lambda_u^{AA}-\lambda_u^{ZA}+\delta\big]\Big]}
\end{aligned} \tag{2.6}$$

$$\begin{aligned}
\frac{u^Z}{m^Z} &= \frac{\delta}{\Big[1-(1-\gamma^{ZC})\big[1-\lambda_u^{ZZ}-\lambda_u^{AZ}+\delta\big]\Big]} \\
&+ \frac{\delta m^A + u^A\Big[(1-\gamma^{AC})\big[1-\lambda_u^{AA}-\lambda_u^{ZA}+\delta\big]-1\Big]}{m^Z\Big[1-(1-\gamma^{ZC})\big[1-\lambda_u^{ZZ}-\lambda_u^{AA}+\delta\big]\Big]} \\
&+ \frac{u^C\Big[\gamma^{CA}(1-\lambda_u^{AC})+\gamma^{CZ}(1-\lambda_u^{ZC})-\delta(\gamma^{CA}+\gamma^{CZ})\Big]}{m^Z\Big[1-(1-\gamma^{ZC})\big[1-\lambda_u^{ZZ}-\lambda_u^{AA}+\delta\big]\Big]}
\end{aligned} \tag{2.7}$$

First, it should be noted that unemployment rates are symmetric across locations. Indeed, it is the discrepancy between the job offer rates that allow to have different unemployment rates. The unemployment rate can be decomposed into three components. The first part of the expression is similar to the classical unemployment rate in the absence of mobility. The only difference lies in the need to take into account the mobility flow. The two other parts of the formula are due to the interactions between markets: individuals' mobility within and between markets.

Once equilibrium unemployment is recovered, I move to the relationship between the earnings distribution and the wage offer distribution. I assume that wage offer distributions are different across locations. Indeed, a notable consequence of the firm location model is the induced segmentation between firms in the location A and Z. That is, the firms targeted by the policy are somewhat small and have a lower productivity. This will result into a distinction between the gross wage offered by firms in A and Z. As a consequence, the distributions of earnings across locations will be different. Furthermore, the commuting costs, and the allocation of individuals along sectors deepens the difference between earning distributions in the two locations. The distribution of earnings is recovered by decomposing the contribution of newly hired workers, job destructions and out of unemployment. For each of those elements, the expression can be decomposed between non mobile households, individuals mobile within the local market and the individuals coming from another local labor market. The flow of employed workers with a wage lower than w in A can be written:

$$
\begin{aligned}
& \underbrace{[1-\gamma^{AC}-\gamma^{AZ}]\left[\lambda_u^{AA}F^A(w)+\lambda_u^{ZA}F^Z(w)\right]u^A}_{\text{Non mobile workers who find a job}} + \underbrace{\gamma^{ZA}G^Z(w)[m^Z-u^Z]}_{\text{Housing market mobility only}} \\
+ \;& \underbrace{\gamma^{ZA}\left[\lambda_u^{AZ}F^A(w)+\lambda_u^{ZZ}F^Z(w)\right]u^Z} \\
+ \;& \underbrace{\gamma^{CA}\left[[\lambda_u^{AC}F^A(w)+\lambda_u^{ZC}F^Z(w)]u^C+\left[\lambda_e^{AC}F^A(w)+\lambda_e^{ZC}F^Z(w)\right][m^C-u^C]G^C(w)\right]}_{\text{Mobile to A after receiving a job offer}} \\
= \;& \underbrace{\left[\lambda_e^{AA}\bar{F}^A(w)+\lambda_e^{ZA}\bar{F}^Z(w)\right][m^A-u^A]G^A(w)}_{\text{Flow of workers in A with a wage higher than w}} + \underbrace{\delta[m^A-u^A]G^A(w)}_{\text{Job losses}}
\end{aligned}
$$

The former equation defined the equality between the flow into the stock (left side) to the flow out of the stock (right side). The expression is different from the one of the former literature because of the mobility flows. More precisely, in the inflow to the stock, I need to take into account the mobility from location Z, and the rest of space.

The corresponding expression for the sub-market Z can be written:

$$
\begin{aligned}
& \underbrace{[1-\gamma^{ZC}-\gamma^{ZA}]\Big[\lambda_u^{AZ}F^A(w)+\lambda_u^{ZZ}F^Z(w)\Big]u^Z}_{\text{Non mobile workers who find a job}} + \underbrace{\gamma^{AZ}G^A(w)[m^Z-u^A]}_{\text{Housing market mobility only}} \\
+ \quad & \underbrace{\gamma^{AZ}[\lambda_u^{AA}F^A(w)+\lambda_u^{ZA}F^Z(w)]u^A} \\
+ \quad & \underbrace{\gamma^{CZ}\Big[[\lambda_u^{AC}F^A(w)+\lambda_u^{ZC}F^Z(w)]u^C+\lambda_e^{AC}F^A(w)+\lambda_e^{ZC}F^Z(w)[m^C-u^C]G^C(w)\Big]}_{\text{Mobile to Z after receiving a job offer}} \\
= \quad & \underbrace{\Big[\lambda_e^{AA}\bar{F}^A(w)+\lambda_e^{ZA}\bar{F}^Z(w)\Big][m^A-u^A]G^A(w)}_{\text{Flow of workers in A with a wage higher than w}} + \underbrace{\delta[m^A-u^A]G^A(w)}_{\text{Job losses}}
\end{aligned}
$$

The former two equations define an equilibrium for each submarket. Furthermore, I impose an equilibrium at the local labor market level which requires the equilibrium wage offer distributions to be solution of the system formed by these two equations:

$$
\begin{cases}
A_1F^A(w)+A_2F^Z(w)=A_3 \\
A_4F^A(w)+A_5F^Z(w)=A_6
\end{cases}
\tag{2.8}
$$

where

$$\begin{aligned}
A_1 &= [1-\gamma^{AZ}-\gamma^{AC}]\left[\lambda_u^{AA}u^A\right]+\lambda_e^{AA}[m^A-u^A]G^A(w)+\gamma^{ZA}\lambda_u^{AZ}u^Z \\
&\quad +\gamma^{CA}\left[\lambda_u^{AC}u^C+\lambda_e^{AC}[m^C-u^C]G^C(w)\right. \\
A_2 &= [1-\gamma^{AZ}-\gamma^{AC}]\left[\lambda_u^{ZA}u^A\right]+\lambda_e^{ZA}[m^A-u^A]G^A(w)+\gamma^{ZA}\lambda_u^{ZZ}u^Z \\
&\quad +\gamma^{CA}\left[\lambda_u^{ZC}u^C+\lambda_e^{ZC}[m^C-u^C]G^C(w)\right. \\
A_3 &= \delta[m^A-u^A]G^A(w)-\gamma^{ZA}[m^Z-u^Z]G^Z(w) \\
&\quad +[\lambda_e^{AA}+\lambda_e^{ZA}][m^A-u^A]G^A(w) \\
A_4 &= [1-\gamma^{ZA}-\gamma^{ZC}]\left[\lambda_u^{AZ}u^Z\right]+\lambda_e^{ZZ}[m^Z-u^Z]G^Z(w)+\gamma^{AZ}\lambda_u^{ZA}u^A \\
&\quad +\gamma^{CZ}\left[\lambda_u^{ZC}u^C+\lambda_e^{ZC}[m^C-u^C]G^C(w)\right. \\
A_5 &= [1-\gamma^{ZA}-\gamma^{ZC}]\left[\lambda_u^{AZ}u^Z\right]+\lambda_e^{AZ}[m^Z-u^Z]G^Z(w)+\gamma^{AZ}\lambda_u^{ZZ}u^Z \\
&\quad +\gamma^{CZ}\left[\lambda_u^{AC}u^C+\lambda_e^{AC}[m^C-u^C]G^C(w)\right. \\
A_6 &= \delta[m^Z-u^Z]G^Z(w)-\gamma^{AZ}[m^A-u^A]G^A(w) \\
&\quad +[\lambda_e^{AZ}+\lambda_e^{ZZ}][m^Z-u^Z]G^Z(w)
\end{aligned}$$

As a consequence, F^A and F^Z are obtained as:

$$F^A(w)=\frac{A_3A_5-A_6A_2}{A_1A_5-A_4A_2} \tag{2.9}$$

$$F^Z(w)=\frac{A_3A_4-A_6A_1}{A_2A_4-A_5A_1} \tag{2.10}$$

This equilibrium wage distribution is consistent with the former literature. That is, for each location there is a nonlinear relationship between the earnings distribution and the wage offer distributions of the firms located either in A and Z.

I now turn my attention to the individual mobility scheme. Individuals make mobility decision according to a simple static discrete choice model. That is, the individual chooses between the following options:

$$\begin{cases} V_0^i = d_u\left[\lambda_u^i\right] + [1-d_u]\left[\lambda_e^i + \lambda_u^i\right] + \xi^i \\ V_1^j = d_u\left[\lambda_u^j\right] + [1-d_u]\left[\lambda_e^j + \lambda_u^j\right] + \xi^j - mc_1 \\ V_2^j = d_u\left[\lambda_u^j\right] + [1-d_u]\left[\lambda_e^j + \lambda_u^j\right] + \xi^j - mc_2 \end{cases} \tag{2.11}$$

Where V_0^i indicates the value of staying in the same housing unit, V_1^j denotes the value of moving to a neighborhood j but staying in the same city while V_2^j is the value associated to a mobility into a neighborhood j in a different market. d_u is a dummy indicating whether or not the individual is unemployed. In this setup, modelling the mobility within the same location would require a more comprehensive model of housing demand. The data does not allow me to do so. As a consequence, I do not consider within location migration. ξ_i is an indirect utility function associated with living in i.[6] I treat it as an unobserved neighborhood component that is estimated. The former mobility decisions yield different mobility costs mc. I will specify the mobility cost to depend on the physical distance between the current and the next location, and the size of the housing unit.

2.2.3.2 Firm choices and productivity

In the static framework and in the absence of a location choice, a relationship between wages and productivity can be derived by taking $\frac{\partial \pi}{\partial w} = 0$.

I assume here that the problem is not only to choose a level of wage, but also a location strategy. That is, a firm will choose its posted wage w and a location with a specific μ that maximizes its profit.[7] One would be interested also in the dynamics of firm mobility. More precisely, how firms will react to the end of the policy.

Therefore, I develop a dynamic model of firm's location. For the sake of simplicity, assume there is no wage renegotiation, and the productivity p is In equation (2.6), both m^A and m^Z can be replaced by their corresponding expression fixed overtime. Each

[6] I assume that this unobserved effect captures the difference between the utility of living into a neighborhood and the associated cost.

[7] There is a large number of firms' relocations over time. The motives of such mobilities are complex and are beyond the scope of this work. The introduction of location specific terms allow to capture this behavior with a minimum assumption.

period, the firm posts the wage that satisfies its *FOC*, and decides whether to move or not. When a firm decides to move, it has to select which of the policy constraints it wants to comply to. As a consequence, the set of choice is extended to eight cases corresponding to the combinations of all the alternatives.[8] The value function of a given choice j is

$$V(j) = \bar{V}(j) + \beta EV(\mathcal{J}) + \epsilon_{1j}$$

where $\bar{V}(j)$ is the deterministic profit function under alternative j, $EV(\mathcal{J})$ the expected value function over the choice set $\mathcal{J}$ and ϵ_{1j} an error term. Assuming the error terms are extreme value distributed, it follows that the probability to make a specific choice k over the set of choices $\mathcal{J}$ is given by:

$$Pr(j, w, \mu) = \frac{\bar{V}_j}{\sum_{j \in \mathcal{J}} \bar{V}_j}$$

Finally, one needs to make sure that the skill specific labor force of firms at each wage w_k is equal to the effective labor supply at w_k.[9] That is, l^A and l^Z solve for the equality between entry into and exit from unemployed:

$$N^A l^A(w) dF^A(w) = \alpha^{AA}\left[m^A - u^A\right] dG^A(w) + \alpha^{ZA}\left[m^Z - u^Z\right] dG^Z(w) \tag{2.12}$$

$$N^Z l^Z(w) dF^Z(w) = \alpha^{AZ}\left[m^A - u^A\right] dG^A(w) + \alpha^{ZZ}\left[m^Z - u^Z\right] dG^Z(w) \tag{2.13}$$

Where α^{ij} is a weight for individuals living in i and working in j. Both $l^A(w)$ and $l^Z(w)$ are obtained as:

[8] Payroll tax cuts, business tax cuts, corporate tax cuts, payroll and business tax cuts, payroll and corporate tax cuts, corporate and business tax cuts, payroll, business and corporate tax cuts, and finally any tax cuts.

[9] Market segmentation holds here, allowing to write an equilibrium condition for each type k. As a consequence, I drop the type index.

$$l^A(w) = \alpha^{AA}\frac{m^A - u^A}{N^A}\frac{dG^A(w)}{dF^A(w)} + \alpha^{ZA}\frac{m^Z - u^Z}{N^A}\frac{dG^Z(w)}{dF^A(w)}$$

$$l^Z(w) = \alpha^{AZ}\frac{m^A - u^A}{N^A}\frac{dG^A(w)}{dF^A(w)} + \alpha^{ZZ}\frac{m^Z - u^Z}{N^A}\frac{dG^Z(w)}{dF^A(w)}$$

2.3 Data

In order to estimate this model, one would have needed a history of individual labor market status, along with residential and working place locations. The analysis of firm location choices and productivity requires firm level data with location at a fine geographical level, and information about firms attributes (size, costs, output). Such a dataset does not exist. As a consequence, I derive the estimation variables from several sources.

In the following, I first present the individual data source and its limitations. I then present how I overcome some limitations using census data. And finally, I present the firm data.

On the individual side, the major issue is related to the lack of a dataset that records at the same time job status and residential mobility. The primary data source is the French Labor survey (FLS) waves from 2003 to 2008. The survey is conducted on a continuous basis (each 3 months) and individuals are interviewed six times. The FLS provides a sequence of labor market states and the corresponding sojourn times. Moreover, I am able to locate individuals and their working place at the finest geographical level, that is the census block or *Ilot*. In order to achieve identification of the parameters of interest, I need to observe a large number of transitions in the data. Given the length of the panel, I try to maximize individual presence in the sample while keeping the model estimable.

I keep for appendix the precise data selection procedure, and for the next subsection the description of the final sample.

Still, there is an issue on the individual side related to the missing of mobility information in the FLS. I use mobility rates computed from the French Permanent

Demographic Survey (FPDS). The FPDS follows 1% of the population over several waves of the census and records any modification in the family size (birth, death, marriage, divorce) from an additional administrative source. [10] Hence, I can document the mobility pattern using this data source, and are able to compute the mobility rate needed for the estimation. However, a change in the methodology of the census complicated the computation of the transition matrix. That is, breaking with the tradition of an exhaustive population census every ten years, the French Statistical Office introduced in 2004 a new sampling method based on annual surveys. In the biggest municipalities, which are of interest here, the new census surveys every year 8% of the housing units. The survey is conducted over a period of 5 years, with the ultimate aim to produce a census data with 40 % of the population every 5 years. Since the FPDS is a collection of census individuals, it is likely that the full sample will not be observed between 2004 and 2009 . More details are provided in appendix, and I describe in the next section the mobility pattern derived from the data.

Finally, the firm mobility estimation employs administrative data sources. All businesses and their local units in France are registered in a national business register called *SIRENE* or "Système national d'Identification du Répertoire des Entreprises et de leurs Etablissements". The information contained in *SIRENE* are obtained on the basis of documents transmitted to the centres for business creation. The information are updated every year based on fiscal and other administrative data. Hence, the dataset provides for each firm its year of creation, sector and location at a fine geographical level. Unfortunately, in the dataset I have been granted access to, the basic firm's characteristics are missing. As a consequence, I use *SIRENE* for a descriptive perspective, since it recorded the mobility and creation, but estimation is carried on *DADS etablissements*. DADS or Annual Declaration of Social Data, is an administrative dataset that contained mandatory declaration of companies workforce and wages.[11] Thus, a DADS is a declaration for one

[10] The survey considers individuals born between the first and the fourth of October, and new immigrants respecting this criteria.

[11] "This document that is common to tax and social administrations, employers, including government administrations and establishments, annually supply, for each establishment, the salaries they have paid,

employee. DADS *etablissements* is obtained by appending all the DADS at firm level. The dataset obtained is a subset of *SIRENE* with the needed information. To summarize, the DADS *etablissements* provides the basic firms characteristics while *SIRENE* allows to locate firms and records a potential mobility.

I can now move to the description of the empirical content of the data.

2.3.1 Descriptive analysis

In this section, I provide the descriptive analysis of the data. I start by describing the sample of individuals from the FLS. After having described their basic attributes, I investigate the nature of the transitions in the labor market. Then, I present some facts about migration, comparing treated and non treated areas. Finally, the mobility of firms is described in the last subsection.

2.3.1.1 Individual level

The final sample is composed of 13,231 individuals with 6.8% of the sample located in a policy area. This rate is higher than the one observed in the general population 2.4%. The table 2.2 describes the cities used for the analysis, and their corresponding sample size. The metropolitan area of Paris represent 46.4% of the sample. Finally, 1.5% of the sample work in a ZFU. This rate moves from approximatively 6.6% in Calais to 0.8% in Lyon.

I can move to a more detailed description of the sample. The Table 2.3 reports the basic characteristics of the individuals in the sample. Both FEZs and ZUS have larger share of young individuals than the other parts of the cities. In comparison to the other locations, the FEZs denote more families with a male head and less individuals living in partnership. A great deal of these families are immigrant, 26.4% in FEZs to be compared to 14.7% in the sample. [12] Not surprisingly, the individuals with an

the employed workforce and a nominative list of their employees, indicating the amount of wages received by each one".

[12]The working population is constituted of individuals active in the labor market, and living into metropolitan areas. This is the reason why the share of immigrants is large.

Table 2.2: Samples per location

Metropolitan Areas	Number of Individuals	Number of Individuals in A	Number of Individuals in Z	Share of individuals Working in a ZFU
Beauvais	114	75	39	1.4
Besançon	544	469	75	1.5
Bordeaux	1,249	1,098	151	3.6
Calais	263	186	77	6.6
Lyon	1,675	1,637	38	0.9
Le Mans	822	751	71	0.8
Marseille	1,412	1,371	41	2.1
Paris	6,136	5,843	293	1.0
Toulon	544	487	57	2.0
Troyes	472	407	65	1.5
Number of observations	13,231	12,324	907	169

associate or college degree account for 15% of the individuals located in a FEZs while they represent around 35% of the general population. This education gap translates into highly stylized occupations and lower wages. Virtually 75% of FEZs inhabitants are either unskilled manual workers or service workers while this rate is around 50% in the population. Similarly, the mean wage in FEZs is around 1,250 € while elsewhere it is close to 1,800 €. An additional explanation of the wage gap lies in the higher share of part time job in the FEZs 17% instead of 15% in the population. By design, the FEZs display strong contrasts with the rest of the metropolitan areas in terms of unemployment. Thus, the unemployment rate is approximately 27% in the FEZs to be compared to 15% in the sample of individuals.[13] The residential mobility rate is higher in FEZs(21%) than in the rest of the space (18)%. The next section will be devoted to the comprehension of this phenomenon.

[13]The high rate of unemployment can be explained by the sample selection procedure. That is, I got rid of all the individuals working in the public sector increasing the weight of unemployed in the population.

Table 2.3: Sample Statistics

		Full	Urban Areas		
		Sample	Non Zus	ZUS	ZFU
Age	15 - 24	12.6	11.8	17.3	18.3
	25 - 39	39.6	39.7	39.1	38.4
	40 - 49	26.1	26.3	24.8	25.6
	50 - 59	20.1	20.5	17.4	16.4
	60 -	1.6	1.7	1.4	1.3
Male		52.6	52.5	53.4	54.9
Married/cohab		64.5	65.7	57.5	64.5
Citizenship	Native	85.3	87.1	74.9	75.9
	Immigrant	14.7	12.9	25.1	26.4
Education	No diploma	28.5	25.3	47.0	48.4
	High school	40.1	40.4	38.2	39.5
	Associates	13.9	15.1	7.3	7.0
	University	17.5	19.2	7.5	5.1
Occupation	Unskilled manual workers	23.8	21.5	37.3	41.4
	Sales and service workers	28.7	27.6	35.1	34.3
	Middle management	24.3	26.0	14.4	12.6
	Senior executive	20.1	22.4	6.5	4.9
	No precise occupation	3.1	2.5	6.7	6.8
Labor Market position	Unemployed	15.2	13.1	27.5	27.1
	Part-time job	15.0	14.8	16.1	17.3
Mobility rate		18.0	17.8	19.2	21.2
Individual net income		1,777	1,846	1,293	1,260
Sample size		13,231	11,305	1,926	907

The characteristics are evaluated at the first interview. The net income is computed on the subset of employed individuals.

Table 2.4: Transitions of individuals initially employed

Type of history	Characteristics of Spells: Number of transitions	Spell Duration	Initial Wage	Final Wage
Full sample	11,220	126.4	1,777	1,940
Mobile individuals	1,835	111.7	1,624	-
Without an unemployment spell	7,408	139.8	1,875	1,914
With at least one transition	1,977	82.8	1,556	1,827
A job to job transition	1,249	5.2	1,782	1,893
With an unemployment spell	842	5.7	1,163	1,218

Wages are in Euros and spell durations in months

Table 2.5: Transitions of individuals initially unemployed

Type of history	Characteristics of Spells: Number of transitions	Spell Duration	Accepted Wage
Full sample	2,009	14.5	1,139
Mobile individuals	552	15.6	-
Without an employment spell	679	29.7	-
Transition to employment	778	6.5	1,139

Wages are in Euros and spell durations in months

After having described the individual characteristics evaluated at the first interview, I focus now on the transitions. I make a difference according to the job status at the initial interview. In the set of employed individuals, I can see that 17% of the sample made at least one transition, while approximately 38% of the unemployed made a transition to employment. The migration rate of employed individuals is around 16.3% to be compared to 27.5% for the unemployed individuals. This suggests that some migrations may be related to a job market transition.

2.3.1.2 Individual mobility after the policy

In this section, I investigate individual mobility over periods corresponding to before and after the policy introduction. I focus on the inflow and outflow from the policy areas.[14]

I compare the flow of individuals who are leaving a FEZ to the flow of individuals who are arriving in a FEZ. As expected, individuals who are leaving the FEZs are much older than the ones who are coming. This phenomenon, not new, is true over the full period and is related to the housing demand over the life-cycle, and the low rents in the FEZs. In terms of the marital status, between 1990 and 1999, a majority of individuals leaving in a FEZ were living in partnership (57%) to be compared to the 46% on the sample of individuals arriving in a FEZ. In comparison with the period 1999 to 2009, there is a smaller proportion of married individuals who are leaving the FEZs.

In terms of social demographic characteristics, the gap between FEZs and the rest of the space is widening over time. That is, from 1990 to 1999, there is at least 89.5% of incoming individuals who are native. Over the next decade, there is only 77.4% of incoming who are native. As a consequence, the share of natives decreases in the FEZs has decreased over time. The same holds for the education level, with a majority of low educated arriving. Another area where the discrepancy between FEZs and the rest of the space keeps deepening is in unemployment rate. Among the individuals who are coming into a FEZ the unemployment rate is around 24% to be compared to an unemployment rate around 14% for the outgoing individuals. This raises a serious question about how to measure the effectiveness of the policy.

Finally, there are few individuals who move to a FEZ in order to achieve homeownership: 18% in 1999 and 20% in 2009. On the other hand, a sizeable share of individuals who leave a FEZ achieve homeownership out of a FEZ (40%). The conjonction of these two events maintain a high share of renting in the FEZs, more specifically public renting.

[14]Several others tables that describe more precisely the mobility patterns are provided in the appendix.

Table 2.6: Transitions in the housing market

Individual Characteristics in 1999		Type of transitions from 1990 to 1999					
		ZUS → ZFU	ZFU → ZUS	Inflow ZUS	Inflow ZFU	Outflow ZUS	Outflow ZFU
Age	10 - 24	14.4	15.6	15.1	15.1	10.2	10.8
	25 - 29	11.3	18.6	16.5	15.9	14.6	17.3
	30 - 39	23.1	31.2	26.3	27.3	35.5	35.6
	40 - 49	20.8	16.4	18.2	18.4	20.1	18.8
	50 - 59	14.8	10.1	12.2	12.1	10.1	9.2
	60 - 99	15.6	8.1	11.7	11.3	9.4	8.2
Male		44.3	42.9	44.9	44.1	46.4	45.8
Married/cohab		43.6	54.0	46.1	47.8	56.7	57.0
Citizenship	Native	84.2	82.3	89.5	86.7	91.9	93.0
	Immigrant	15.8	17.7	10.5	13.3	8.1	7.0
Education	No diploma	49.2	49.9	42.0	34.9	32.3	31.7
	Vocational	32.5	33.5	33.1	32.6	36.7	37.7
	High school	10.4	8.1	12.4	14.0	13.3	13.6
	Associates	4.9	5.1	6.7	9.3	9.7	9.7
	University	3.0	3.4	5.8	9.2	8.0	7.3
Job Status	Unemployed	27.2	31.1	24.8	23.4	15.4	16.9
Tenure	Homeownership	20.6	13.3	18.2	18.4	40.0	39.4
	Renting	73.6	79.1	74.1	73.9	52.4	52.4
Individual Characteristics in 2009		**Type of transitions from 1999 to 2009**					
		ZUS → ZFU	ZFU → ZUS	Inflow ZUS	Inflow ZFU	Outflow ZUS	Outflow ZFU
Age	20 - 24	11.6	13.9	12.9	13.6	9.1	9.1
	25 - 29	17.7	15.2	15.9	16.5	10.7	10.7
	30 - 39	28.1	26.1	27.0	27.2	31.6	30.8
	40 - 49	19.5	17.2	18.4	15.9	23.3	23.4
	50 - 59	14.6	12.3	12.4	12.8	11.6	11.1
	60 - 99	8.5	15.3	13.4	14.1	13.7	14.9
Male		44.5	47.1	45.9	44.7	47.5	47.1
Married/cohab		48.8	49.7	50.4	48.9	34.9	37.2
Citizenship	Native	68.9	67.6	77.4	74.9	83.9	81.6
	Immigrant	31.1	32.4	22.6	25.1	16.1	18.4
Education	No diploma	42.1	41.0	30.4	33.4	26.1	27.2
	Vocational	32.9	34.6	31.3	32.9	36.2	36.7
	High school	14.0	13.4	17.3	16.1	16.6	16.6
	Associates	4.9	6.9	10.9	10.2	12.0	11.8
	University	6.1	4.1	10.1	7.6	9.1	7.6
Job Status	Unemployed	27.4	26.4	23.2	20.6	14.0	14.6
Tenure	Homeownership	19.5	14.0	20.0	19.8	41.4	41.3
	Renting	73.2	73.2	71.8	72.3	51.0	50.8

The individual characteristics are evaluated at last period.

Table 2.7: Transitions in the labor and housing markets

	Type of transitions from 1990 to 1999						
	Mobile -	Not mobile	Inflow ZUS	Outflow ZUS	Inflow ZFU	Outflow ZFU	General Population
Exit from unemployment (%)	81.4	95.4	37.5	0	66.7	100	86.3
Entry into unemployment (%)	7.6	5.7	14.7	15.3	9.1	8.6	6.9
	Type of transitions from 1999 to 2009						
	Mobile -	Not mobile	Inflow ZUS	Outflow ZUS	Inflow ZFU	Outflow ZFU	General Population
Exit from unemployment (%)	77.0	70.5	62.8	62.4	72.6	70.5	74.4
Entry into unemployment (%)	5.6	4.0	11.0	14.2	6.9	6.4	4.7

Finally, I investigate whether or not a migration is followed by a transition in the labor market. The table 2.7 computes the share of individuals who made a transition into employment and unemployment. Compared to the general population of mobile individuals, the individuals who are arriving in a FEZ, exit less unemployment and entry more into it.

2.3.1.3 Firm level

I consider another assessment of the policy effectiveness using the mobility of firms. From 1995 to 2007, a total of 4.36 millions firms has been created in France, with a share of 1.2% in the areas subject to the policy. [15] About 1.9 millions firms made a mobility with 1.7% of them moving to a FEZ. As shown in table 2.8, firms implantation is very sensitive to the size and the sector. On the one hand, the lowest implantation rates (0.2 % and 0.3 % occur for the sectors of public services and transport. On the other hand, the highest implantation rate (2.5% and 1.5%) construction and support to firms. While, security issues may explain the lack of implantation into public services, the low rate of implantation of transport sector firms could be explained by the inner location of the

[15] I define firm creation as including a taking-over.

FEZs. The high rate of implantation of firms in the construction sector is likely to be explained by cuts in the social security contribution which are particularly high in the construction because of the frequency of accidents. The high rate of firms in support to firms may be explained by the nature of the task which most of the time does not require a physical presence in the office. When I consider the survival of new firms, only 2.5 millions of them still exist in 2008. This yields a survival rate of 57%. There is no significant difference between FEZs and the rest of space.

Table 2.8: Patterns of firms location from 1995 to 2007

Type of creation	Sector	Locations							
		Non ZFUs				ZFUs			
		Number of employees							
		Missing	0	1-49	50 and +	Missing	0	1-49	50 and +
Creation	Missing	-	5,737	2,191	34	-	92	24	-
	Real estate	7,281	128,773	25,210	37	62	747	172	2
	Trade	52,483	861,738	360,784	4,188	804	11,373	3,501	24
	Construction	18,011	379,176	155,377	1,278	551	7,718	6,033	11
	Energy	4,460	7,325	1,295	214	23	48	12	2
	Industry	12,089	196,695	122,217	4,453	124	1,450	1,188	21
	Sces to Firms	50,234	598,120	149,514	3,453	599	7,725	2,766	25
	Services	26,889	494,255	234,606	665	171	2,432	1,379	3
	Transport	4,756	86,351	38,799	1,138	108	1,915	747	3
	Total	172,203	2,758,170	1,089,993	15,882	2,442	33,500	15,822	91
	All sectors	4,039,827				51,855			
Mobility	Missing	-	1,512	976	26	-	41	25	-
	Real estate	3,508	35,070	14,758	74	24	208	104	-
	Trade	13,169	126,303	106,631	1,111	213	1,661	1,598	5
	Construction	9,245	81,414	93,627	814	233	1,348	3,376	12
	Energy	101	922	422	85	1	4	6	2
	Industry	4,914	42,422	52,775	1,504	80	379	893	13
	Sces to Firms	20,448	188,414	127,676	3,137	405	2,696	3,333	36
	Services	5,268	56,804	20,323	208	38	260	173	3
	Transport	3,036	29,913	22,576	608	59	472	629	2
	Total	59,689	562,774	439,764	7,567	1,053	7,069	10,137	73
	All sectors	1,069,794				18,332			

2.4 Estimation and Calibration

In this section, I estimate the model using the data described. In the first subsection, I present the estimation procedure. In the second, I present the strategy of policy evaluation that consists of simulating the job offer rate before the policy introduction. Finally, I present the calibration of the parameters not identifiable.

For this estimation exercise, I restrict my attention to the cities with at least a sample size of 40 individuals. I assume 3 types of skill levels in the sample.

2.4.1 Structural estimation

Because of the extremely limited sample size in several neighborhoods, and the number of parameters to be estimated, I develop a Bayesian estimation method that tends to have better finite sample properties. Another advantage of the Bayesian approach is that the computation time is 5 times lower.

Estimate the type of workers

The type of workers is estimated using an index function specified as:

$$Pr_k = \frac{\log(\tau_{0k} + \tau_{1k}Z_1 + \tau_{2k}Z_2)}{1 + \sum_K \log(\tau_{0k} + \tau_{1k}Z_1 + \tau_{2k}Z_2)} \tag{2.14}$$

Where Z_1 is the education level, and Z_2 the gender. I set the number of types k to 3.

At iteration s, assume the set of structural parameters $\eta_s = \{\lambda_u^s, \lambda_e^s, \delta\}$ are set. The mobility rates γ^s are set such that they are consistent with the general population, and $\mu_i^{(s)}$ are also obtained. Then, the estimation procedures are as follows.

Earning and wage offer distribution

Individual wage data allows to evaluate the earning distributions for each location, $g^A(w)$, $g^Z(w)$ and $g^C(w)$. The Kernel estimator for the density of earnings is :

$$\hat{g}(w) = \frac{1}{nh}\sum_{i}^{n} K\left(\frac{w - w_i}{h}\right) \tag{2.15}$$

where n is the number of observations, and h is the bandwidth.

After testing several functional forms, I conclude that its choice has not much effect on the estimation. Therefore, I use a gaussian kernel. Finally, I need to account for the bias induced by the truncation in the earnings distribution, I follow the literature and use the specific kernel estimator:

$$\hat{g}(w) = \frac{1}{nh}\sum_{i}^{n}\left[\phi\left(\frac{w - w_i}{h}\right)\right]\left[\Phi\left(\frac{w - \underline{w}}{h}\right)\right] \tag{2.16}$$

The cumulative distribution $G^A(w)$, $G^Z(w)$ and $G^C(w)$ can be obtained by numerical integration. Then, equations (2.9) and (2.10) define a relationship between the wage offer distribution, and the earnings. Hence, I can obtain both $F^A(w)$ and $F^Z(w)$. Finally, taking the derivatives yields an expression for $f^A(w)$ and $f^Z(w)$.

Structural parameters estimation

With the wage offer distributions, I am now in position of estimating the labor market primitives. In the first step, I estimate the location unobserved heterogeneity parameter. In the second, the primitives of the model are recovered.

Location specific parameter estimation Given the calibration of the mobility cost, and the initial parameters, estimate $\zeta^{(s+1)}$ by minimizing the distance between the mobility rate as predicted by the individual location choice model and the mobility rate observed in the FPDS (pm^d)

$$\zeta_i^{(s+1)} \mid pm(\zeta_i^{s+1}) - pm^d \simeq 0$$

Labor market structural parameters, Metropolis-Hasting Draw the structural parameter $\eta^{(s+1)}$ by using the Metropolis-Hastings algorithm. That is, draw the candidate structural parameters η^* from the proposal density $\pi_\eta(\eta^*|\eta^{(s)})$. Then, derive the acceptance probability

$$P_a = min\left\{\frac{\mathcal{L}(\eta^*)\pi_\eta(\eta^{(s)}|\eta^*)}{\mathcal{L}(\eta^{(s)})\pi_\eta(\eta^*|\eta^{(s)})}, 1\right\} \tag{2.17}$$

where $\mathcal{L}$ is the likelihood, as defined in appendix.

That is, let $\eta^{(s+1)} = \eta^*$ (i.e., accept) with probability P_a and let $\eta^{(s+1)} = \eta^{(s)}$ (i.e., reject) with probability $1 - P_a$.

Firm productivity distribution

The *FOC* condition of the firms profit maximizing defines a mapping between the wage level and the productivity. I assume that this relationship can be described by

$$w = K(q) = K(p + \mu) \tag{2.18}$$

The next task is to decompose the firm productivity between its specific component and the location effect while respecting the constraints imposed by the policy.

Data augmentation for the location specific effect, Metropolis-Hasting Draw the location fixed effect $\mu^{(s+1)}$ by using the Metropolis-Hastings algorithm. That is, draw the candidate parameters μ^* from the proposal density $\mu_\mu(\mu^*|\mu^{(s)})$. Then, derive the acceptance probability

$$P_a = min\left\{\frac{\mathcal{L}_f(\mu^*, w)\pi_\mu(\mu^{(s)}|\mu^*)}{\mathcal{L}_f(\mu^{(s)}, w)\pi_\mu(\mu^*|\mu^{(s)})}, 1\right\} \tag{2.19}$$

where $\mathcal{L}_f$ is the likelihood associated to firm mobility as defined in the appendix.

That is, let $\mu^{(s+1)} = \mu^*$ (i.e., accept) with probability P_a and let $\mu^{(s+1)} = \mu^{(s)}$ (i.e., reject) with probability $1 - P_a$.

Firm specific productivity Recover $P + \mu$ taking $K^{-1}(w)$, and obtain P as $K^{-1}(w) - \mu$

2.4.2 Policy evaluation

I now turn to the policy evaluation part. I assume that the job arrival rate is specified as:

$$\lambda^{ij} = f_1(n_j) + f_2(u_j) + f_3(\psi_{ij}) + f_4(\xi_i + \mu_i) \tag{2.20}$$

Where n_j is the share of firms in the submarket located in j, u_j is the unemployment rate in j and ψ_{ij} is the distance between i and j.[16] I do not assume any functional form for the relationship between the job offer rate and its determinants. However, I assume additivity to simplify the estimation issues.

2.4.3 Identification

The identification results of the structural search model are well known in the literature see e.g Flinn and Heckman (1982). It is well known from Magnac and Thesmar (2002) that the identification of the discount factor is complicated, so I do not attempt to estimate it. Because identification of the model parameters hinges on "qualitative" features of the empirical transitions and wage distributions, it is essential to have precise empirical estimates. I hope the restrictive data selection helps for that purpose.

2.4.4 Calibration and functional form assumption

As stated before, several parameters can not be identified, therefore I calibrate them. In order to calibrate the job arrival rate between regions, I use a feature of the Labor Survey. During the first interview, individuals are asked about their location and job status one year before. For the set of individuals who made a mobility in the housing market, I compute the rate at which they find a job.

Table 2.5 summarizes the calibration of job offer rates obtained from the 2002 Labor Survey. λ^{CA} and λ^{CZ} are obtained by averaging out the job offer rates in the other markets. The job-to-job transition rate observed in this dataset is extremely low between

[16] Most of the time, there are several neighborhoods that compose both A and Z in this framework. I consider here the mean distance between the center of A and each of the neighborhood that composed Z.

Table 2.5: Data based calibrated parameters

Parameters	Local labor markets									
	Beauvais	Besancon	Bordeaux	Calais	Le Mans	Lyon	Marseille	Paris	Toulon	Troyes
γ^{AA}	23.3	25.5	51.3	53.2	35.5	55.5	52.7	55.2	69.0	45.1
γ^{AZ}	1.6	2.9	2.1	6.0	1.4	1.9	0.01	2.3	1.7	2.6
γ^{AC}	75.1	71.6	46.6	40.8	63.0	42.6	47.1	42.5	29.3	52.3
γ^{ZZ}	26.9	47.9	49.3	59.6	36.4	53.3	71.2	50.2	52.6	34.2
γ^{ZA}	34.6	16.4	19.7	15.4	22.7	17.1	0.01	25.9	36.9	34.2
γ^{ZC}	38.5	35.6	31.0	25.0	40.9	29.5	29.7	24.0	10.5	31.6
γ^{CA}	2.2	3.9	7.8	0.9	3.9	10.0	6.2	61.6	2.5	1.9
γ^{CZ}	0.01	5.6	6.7	2.2	4.5	5.6	5.6	59.6	4.5	5.6
λ_u^{AC}	0.040	0.10	0.07	0.04	0.11	0.085	0.048	0.069	0.065	0.047
λ_u^{ZC}	0.007	0.018	0.007	0.009	0.01	0.006	0.002	0.007	0.007	0.006
λ_u^{CA}	0.07	0.063	0.067	0.07	0.062	0.065	0.060	0.067	0.067	0.069
λ_u^{CZ}	0.008	0.067	0.008	0.0077	0.0076	0.0081	0.007	0.0085	0.008	0.0081
λ_e^{AC}	0.01									
λ_e^{ZC}	0.001									
λ_e^{CA}	0.01									
λ_e^{CZ}	0.001									

locations, and with very few heterogeneity. As a consequence, I set the parameters to be equal over the set of markets.

I assume here that the job arrival rate depends on the type of individuals.

I also need to impose a functional form for the capital $c(p,\mu)$ and the moving cost cm. I assume

$$c(p,\mu) = Ap^{\theta}\mu^{1-\theta}$$

$$cm = 0.06 \times c(p,\mu)$$

This calibration is standard in the literature on migration. Finally, I assume that

$$mc(s,d) = 5 * \log(1+d) * \exp(s^{1/3})$$

Where d is the distance between locations, and s is the floor area of the departing housing unit.

2.5 Results

The estimated parameters are obtained using Bayesian MCMC. I ran 20,000 iterations, with the first 5,000 dropped for burn-out. Standard deviations are obtained as the dispersion during convergence.

2.5.1 Structural parameters estimation

In this section, I report the results of the estimation. I ignore for now the estimation of job-to-job transition rates, and focus on rates out of unemployment. The table 2.6 summarizes the unobserved heterogeneity component. The location specific unobserved component for firms is estimated by sector. In the table 2.6, I present the sum over sectors. The results demonstrate that FEZs are still very unattractive both to firms and individuals. That is, the gap in firm attraction goes from 1 to 6 in Troyes, to 1 to 100 in Lyon. In terms of job destruction rate, there is no significant difference between the three types of individuals. As a consequence, I report the mean job destruction rate. In contrast to the former literature, the estimates for job destruction are particularly high. The reported job destruction rates are over a period of 18 months to be consistent with the calibration of job offer rates between markets.

Table 2.6: Estimation results: Unobserved heterogeneity and job destructions

Parameters	Local labor markets				
	Beauvais	Besancon	Bordeaux	Calais	Le Mans
μ^A	0.34	0.27	0.51	0.15	0.32
μ^Z	0.01	0.005	0.04	0.003	0.02
ξ^A	0.41	0.50	0.84	0.32	0.45
ξ^Z	0.03	0.02	0.15	0.02	0.09
δ	0.11	0.17	0.09	0.19	0.15
	[0.09-0.12]	[0.16-0.018]	[0.085-0.095]	[0.14-0.26]	[0.09-0.18]
	Lyon	Marseille	Paris	Toulon	Troyes
μ^A	0.67	0.36	0.78	0.31	0.25
μ^Z	0.007	0.002	0.04	0.03	0.07
ξ^A	0.57	0.26	0.88	0.31	0.42
ξ^Z	0.01	0.01	0.02	0.05	0.17
δ	0.14	0.13	0.21	0.18	0.09
	[0.12-0.16]	[0.10-0.16]	[0.20-0.22]	[0.16-0.21]	[0.08-0.10]

In square brackets: the 2.5% and 97.5% percentiles of the posterior distribution

Table 2.7: Estimation results: Job offers

Parameters			Local labor markets		
by type	Beauvais	Besancon	Bordeaux	Calais	Le Mans
λ_u^{AA}	0.151	0.162	0.181	0.158	0.164
	[0.145-0.156]	[0.152-17.1]	[0.178-0.184]	[0.152-0.164]	[0.159-0.169]
λ_u^{AZ}	0.018	0.017	0.042	0.019	0.011
	[0.013-0.024]	[0.015-0.019]	[0.039-0.045]	[0.018-0.020]	[0.008-0.014]
λ_u^{ZZ}	0.008	0.004	0.015	0.007	0.006
	[0.006-0.010]	[0.001-0.006]	[0.010-0.019]	[0.003-0.009]	[0.005-0.008]
λ_u^{ZA}	0.003	0.005	0.004	0.002	0.004
	[0.001-0.005]	[0.003-0.008]	[0.002-0.006]	[0.0014-0.0026]	[0.003-0.006]
λ_u^{AA}	0.096	0.103	0.076	0.081	0.091
	[0.087-0.104]	[0.092-0.101]	[0.073-0.079]	[0.077-0.087]	[0.085-0.095]
λ_u^{AZ}	0.015	0.011	0.029	0.014	0.008
	[0.011-0.021]	[0.008-0.015]	[0.025-0.035]	[0.009-0.020]	[0.006-0.011]
λ_u^{ZZ}	0.005	0.006	0.011	0.004	0.003
	[0.003-0.008]	[0.003-0.009]	[0.009-0.013]	[0.003-0.005]	[0.001-0.005]
λ_u^{ZA}	0.004	0.002	0.003	0.001	0.003
	[0.001-0.006]	[0.001-0.003]	[0.001-0.006]	[0.0006-0.0017]	[0.001-0.005]
λ_u^{AA}	0.071	0.068	0.089	0.077	0.095
	[0.067-0.078]	[0.065-0.070]	[0.071-0.083]	[0.071-0.082]	[0.087-0.101]
λ_u^{AZ}	0.007	0.006	0.013	0.011	0.005
	[0.006-0.009]	[0.003-0.009]	[0.009-0.017]	[0.006-0.019]	[0.003-0.009]
λ_u^{ZZ}	0.015	0.012	0.021	0.009	0.008
	[0.011-0.021]	[0.009-0.015]	[0.017-0.027]	[0.005-0.015]	[0.006-0.011]
λ_u^{ZA}	0.004	0.007	0.009	0.003	0.005
	[0.003-0.005]	[0.004-0.009]	[0.007-0.013]	[0.001-0.005]	[0.003-0.009]
	Lyon	Marseille	Paris	Toulon	Troyes
λ_u^{AA}	0.177	0.161	0.182	0.148	0.155
	[0.171-0.184]	[0.159-0.163]	[0.177-0.189]	[0.143-0.0152]	[0.151-0.211]
λ_u^{AZ}	0.021	0.012	0.035	0.016	0.023
	[0.017-0.025]	[0.009-0.015]	[0.031-0.039]	[0.012-0.020]	[0.018-0.027]
λ_u^{ZZ}	0.006	0.011	0.008	0.009	0.012
	[0.004-0.008]	[0.005-0.007]	[0.008-0.015]	[0.006-0.013]	[0.008-0.015]
λ_u^{ZA}	0.008	0.010	0.002	0.005	0.011
	[0.005-0.013]	[0.006-0.013]	[0.001-0.004]	[0.003-0.008]	[0.007-0.015]
λ_u^{AA}	0.151	0.062	0.093	0.057	0.064
	[0.148-0.155]	[0.055-0.067]	[0.085-0.099]	[0.051-0.062]	[0.060-0.067]
λ_u^{AZ}	0.010	0.009	0.012	0.017	0.021
	[0.008-0.012]	[0.008-0.011]	[0.009-0.016]	[0.014-0.020]	[0.018-0.024]
λ_u^{ZZ}	0.008	0.016	0.009	0.014	0.016
	[0.004-0.012]	[0.005-0.013]	[0.005-0.014]	[0.010-0.018]	[0.013-0.019]
λ_u^{ZA}	0.009	0.015	0.007	0.011	0.015
	[0.007-0.012]	[0.004-0.013]	[0.005-0.009]	[0.008-0.015]	[0.012-0.018]
λ_u^{AA}	0.11	0.057	0.055	0.061	0.049
	[0.107-0.114]	[0.052-0.61]	[0.053-0.058]	[0.057-0.066]	[0.046-0.052]
λ_u^{AZ}	0.011	0.008	0.007	0.011	0.007
	[0.008-0.014]	[0.006-0.011]	[0.002-0.011]	[0.007-0.014]	[0.006-0.008]
λ_u^{ZZ}	0.020	0.035	0.019	0.014	0.011
	[0.018-0.023]	[0.03-0.037]	[0.013-0.025]	[0.010-0.018]	[0.008-0.015]
λ_u^{ZA}	0.016	0.027	0.031	0.012	0.016
	[0.012-0.019]	[0.022-0.031]	[0.026-0.037]	[0.007-0.015]	[0.014-0.018]

In square brackets: the 2.5% and 97.5% percentiles of the posterior distribution

2.5.2 Policy evaluation

In this section, I analyze the effectiveness of the policy based on inference before the policy. In order to evaluate the overall effect of the policy, I use the average job offer rate across individual types.[17] The job arrival rates are derived using the following algorithm:

1. Obtain μ^A and μ^Z by estimating the location choice model on the years prior to the policy introduction and under constant wage assumption.

2. Obtain the location specific unobserved ξ, and compute the job arrival rate as follows.

   (a) Use the mobility rate from 1990 to 1995 to fit ξ^A and ξ^Z.

   (b) Find a new set of job arrival rates (λ_u, and λ_e) to fit the mobility rates.

   (c) Repeat until convergence

As shown in the table 2.8, the job arrival rate is higher after the policy than before although, the difference is insignificant. There is some heterogeneity between local labor markets. This positive effect holds for residents of the location A, however one should note that this effect is in the best case an indirect effect of the policy via the increase in ξ^A. Surprisingly, the model predicts a decrease in the job arrival rate towards workers in Z. This is mainly driven by the effect of location unobserved ξ on job arrival rate. More precisely, the model predicts lower ξ prior to the policy introduction. The extent to which this is a consequence of the policy remains unclear. On the one hand, it is been argued that the policy may have had a stigma effect or revealed the negative unobserved component of the treated zones. On the other hand, one can argued that segregation is a self enforcing mechanism that would have increased even more without the policy. My model do not include any mechanism for increased segregation over time. Anyhow, one should note that a substantial share of enterprise zones have benefited from an urban renewal program. This program have demolished old and large public housing

[17]We focus for now

Table 2.8: Estimations and simulations of the effect of the policy

Parameters		Local labor markets				
		Beauvais	Besancon	Bordeaux	Calais	Le Mans
After	λ_u^{AA}	0.106	0.111	0.1113	0.10933	0.1166
	λ_u^{AZ}	0.013	0.011	0.028	0.0146	0.008
	λ_u^{ZZ}	0.0093	0.0073	0.0156	0.0066	0.0056
	λ_u^{ZA}	0.0036	0.0046	0.0053	0.002	0.004
Before	λ_u^{AA}	0.104	0.110	0.112	0.108	0.1061
	λ_u^{AZ}	0.012	0.011	0.029	0.015	0.009
	λ_u^{ZZ}	0.0093	0.0074	0.0159	0.0067	0.0055
	λ_u^{ZA}	0.0037	0.0045	0.0055	0.0022	0.0041
		Lyon	Marseille	Paris	Toulon	Troyes
After	λ_u^{AA}	0.113	0.093	0.11	0.088	0.089
	λ_u^{AZ}	0.014	0.009	0.018	0.014	0.017
	λ_u^{ZZ}	0.0113	0.0206	0.0120	0.0123	0.013
	λ_u^{ZA}	0.011	0.0173	0.0133	0.0093	0.014
Before	λ_u^{AA}	0.112	0.094	0.11	0.088	0.090
	λ_u^{AZ}	0.014	0.009	0.017	0.013	0.017
	λ_u^{ZZ}	0.0115	0.0206	0.0136	0.0124	0.0135
	λ_u^{ZA}	0.011	0.0172	0.0129	0.0095	0.0148

projects to build smaller projects. The conditions to benefit from these new housing were tightened to favor working families.[18] If the ultimate goal of the policy was to decrease the level of spatial inequalities, it fails. In the best scenario, it may have slowdown the increase in segregation.

2.6 Extensions

Now, I consider some extensions. First, I investigate on the number of firms needed to close the gap between the FEZs and the rest of the space. That is, maintaining all the other determinants of the job offer rate except the number of firms and the agglomeration effects, I consider the increase in the number of firms that would generate an equal offer rate across locations. To do so, I start with an artificially high number of relocations in the FEZ, and I estimate a new agglomeration effect. I iterate until reaching the number

[18] New homeowners have to be occupy their new dwelling for next eight years, while renters could obtain a dwelling only via the works council excluding de facto unemployed individuals.

Table 2.9: Number of firms needed to equalize job offer rates

Parameters	Local labor markets				
	Beauvais	Besancon	Bordeaux	Calais	Le Mans
Coefficient	17.8	19.2	15.8	22.9	16.5
	Lyon	Marseille	Paris	Toulon	Troyes
Coefficient	20.9	21.5	20.7	19.5	17.2

of firms and the μ that yield the same job offer rates for individuals in A and Z. In the next table I report the number by which the number of firms should be multiplied.

As shown in the table 2.9, for the policy to circumvent the differences between locations in terms of job rate, the number of firms should increase very substantially. The proportionality parameter is around 20. One should keep in mind that the number of firms increases by 2 from 1995 to 2008. The cost of such a policy can not be forecast since it will require to modify several constraints of the policy in order to attract more firms. Those constraints act as cost control mechanisms because they limit the size and the productivity of the targeted firms.

I now propose a decomposition of the job arrival rate based on its component and on the semiparametric model estimated before.

Table 2.10: The decomposition of job offer rates

Components	Share
n	7.1
u	8.4
Distance between locations	42.3
Individual unobserved ξ	11.5
Agglomeration effects μ	15.7

The decomposition of job offer rates shows that the variables measuring the tension in the local labor market account for approximately 15 % of differences in the job offer rate. The spatial frictions account for more than 40% of the gap between job offer rates. These results are driven by the difference in magnitude between λ_u^{AA} and λ_u^{AZ}.

2.7 Conclusion

In this essay, I developed and estimated an equilibrium search model to evaluate the French Enterprise Zones policy. I extend the existing literature by bringing together search theory and urban economic in a tractable model. Moreover, I incorporate the features of tax holiday policies. I develop a new comprehensive theory of individual and firm location choices in a presence of a binding policy. Search frictions as well as spatial frictions are modelled.

I structurally estimate the model using a multi-stage algorithm with hierarchical Bayesian, and nonparametric estimation procedure. The estimation results suggest that the policy was not effective in curbing unemployment. According to the model, the number of firms in the FEZs should be increased by at least 20 before getting equality between locations. Moreover, the model exhibits the importance of spatial frictions, and of unobserved effects. Given the cost of the policy, and the required steps for its effectiveness, one may consider a shift in the policy. In the short run, a policy that would subsidized outgoing mobility of unemployed could be introduced. Such a policy would increase the likelihood of finding a job. While, in the long run, policies that affect the quality of life and therefore affect the unobserved heterogeneity parameters should be considered. I believe that this framework represents an advance in the evaluation of public policy in the presence of frictions, opportunistic firms and agents, and potential general equilibrium effects. Nonetheless, the paper suffers from limitations. The first and the most obvious one is related to the absence of search effort in the model. Indeed both firms and individuals may need to engage into a costly search process. Given the level of segregation, and the distribution of skilled workers in space, one may wonder how the potential search cost affect firms' location choices. A framework similar to Ferrall (2008) could provide new insights and a natural extension to this work.

Essay 3

A Unified Framework For The Analysis of Inequalities

Introduction

A new empirical literature has emerged that examines the determinants of inequalities over lifetime. **?**, Keane and Wolpin (1997), **?** and Heer (2001), among others, have proposed explanations based on differences across individuals (ability, skills, and human capital) and the role played by generational transmissions. Surprisingly, a powerful determinant of lifetime inequalities is left apart. Indeed, Benabou (1993) shows the key role played by heterogeneity between locations in generating inequalities. However, Benabou's framework does not include a comprehensive theory of housing demand. As a consequence, an important determinant of inequalities which operates through the dynamics of prices across locations is missing. Indeed, there are potential large spillover effects between the outcomes of individuals in the labor, housing and education markets. Among these three markets, housing is the crucial determinant of lifetime inequalities by its importance in the household's portfolio and the bridge it builds between education and labor markets.

This paper tries to fill this gap by proposing a unified framework for the analysis of inequalities. I develop an overlapping generation model in the spirit of **?**, Huggett (1993) and Aiyagari (1994). The standard life-cycle model is modified to allow for heterogeneous agents, a realistic housing market and aggregate uncertainty. This general framework allows to evaluate household behavior in a lumpy housing market with renting and owning. Moreover, heterogeneity between locations with respect to their level of social capital is included.[1] The level of social capital in a location influences household labor productivity and the level of human capital of the next generation. The model allows for endogenous housing prices based on individual expectations. The price level affects the timing of homeownership and the set of locations in which it is possible for a given household to buy a dwelling. Furthermore, the expected price growth plays a significant role in the individual saving decision and location choice.

At a household level, the key mechanism underlying the model is the trade-off between the level of social capital and housing prices. For a given household, the level of social capital of its residential location influences labor productivity. Moreover, parents' transmission to their children operates through a bequest motive, but also through the impact of local social capital on children's human capital formation. A large body of literature studies the relationship between children outcomes and the characteristics of their childhood neighborhood (see e.g Oreopoulos, 2003). I specify two mechanisms allowing location to affect children outcomes. First, education infrastructure differs across locations. This assumption captures the fact that educational attainments differ across locations not only because of the sorting on student ability but also as a matter of differences in schooling infrastructure. Second, the level of social capital in the neighborhood affects the human capital acquisition of the next generation. The heterogeneity in school quality between locations leads to differences in the next generation level of human capital. As a consequence, households have a higher preference for the neighborhood

[1] In the literature, social capital is defined broadly as social cohesion, and personal investment into community. As a consequence, it refers to a notion of cooperation at a community level. I will use this broad concept to define how the well-being into a community affects the productivity of adults, and the human capital acquisition of children.

with the highest level of social capital, but some may be finance constrained due to the cost of a housing unit. The fixity of housing supply in each neighborhood combined with the borrowing constraints prevent some households from living in their preferred area, which leads to segregation and further strengthens inequalities.

Hence, the effects of borrowing constraints are reinforced by their implications not only for parents but also children. This form of borrowing constraint is more appealing than in the existing literature since households should be allowed to borrow not only against their future income but also against the future income of their children.

For empirical purpose, a unique dataset that provides information on individual characteristics (Census Data), income and wealth (Wealth Surveys), housing prices (Housing Surveys) and the spatial differences over locations (Censuses) is created for France. On the methodological front, this paper contributes to the literature by matching the nonparametric kernel distribution simulated by the model to the data. This more demanding approach in terms of computation provides a more accurate representation of the distribution.

This benchmark allows to run several experiments to assess whether or not a voluntary policy can decrease the level of inequalities.

This paper contributes to the literature by providing a unified framework that encompasses all the transmission channels of inequalities (wealth inheritance, transmission of ability, role of capital market imperfections, spatial inequalities). The model focuses on the features of neighborhoods as of the main determinants of both short-run and long-run inequalities. Using a general framework where the interactions between housing, labor and education markets are represented, I can bring together several parts of the literature which are inherently close but were diverging until now. On the one hand, the literature on segregation provides several pieces of evidence on the impact of neighborhoods in the generation of cross-section inequalities (see e.g. for racial segregation Cutler and Glaeser, 1997; Bajari and Kahn, 2005 and for income stratification Epple and Sieg, 1999). On the other hand, an extensive body of literature tries to decompose lifetime inequality (Castaneda, Diaz-Gimenez, and Rios-Rull, 2003; **?** and Piketty, 2000 for an emphasis on social capital).

For years, the literature on intergenerational mobility has been held back because of the lack of reliable data sources. In the recent period, administrative Scandinavian data have allowed better measures of intergenerational inequalities. The problem remains for bigger developed countries. Using standard datasets, the results differ widely.[2] The surveys by Solon (1999) and Piketty (2000) provide two interesting overviews with differentiated emphasis.[3] Here, the predictive quality of the model is used to report empirical evidence about intergenerational mobility.

The rest of this paper is organized as follows: in the first section, the related literature is presented. In the second, the model and the computation strategy are presented. In the third, the data are presented with an emphasis on the spatial and life-cycle dimension of the variables of interest. In the fourth section, I present the results and their implications. Finally, several policy experiments are simulated.

3.1 Previous Literature

The existing literature on inequalities focuses on two topics: the decomposition of lifetime inequalities, and the determinants of wealth concentration.[4] In this section, I focus on the determinants of lifetime inequalities and the macroeconomic literature that tries to mimic wealth distribution.

First, the sources of lifetime inequalities have been extensively analyzed. Some findings from

Keane and Wolpin (1997), Storesletten, Telmer, and Yaron (2004) and **?** are summarized. The question is to quantify respectively the share of lifetime inequalities that can be attributed to differences in initial conditions and to shocks received over lifetime.

[2]The most used datasets are the Panel Study of Income Dynamics, the British Cohort Study, The German Socio-Economic Panel and the French Wealth Surveys.

[3]Solon (1999) analyses the intergenerational mobility with an emphasis on insight from the data, Piketty (2000) investigates the inequalities in the long run and tries to infer about transfers from parents to children.

[4]The reader interested in dynamics of wealth concentration should take a look at **?** for the US, **?** for France, and **?** for Switzerland.

Among all these models, Keane and Wolpin (1997) are the only one to consider structural estimation. Keane and Wolpin (1997) estimate a realistic model of career choice for a sample of young men. They find that differences across individuals realized at age 16 accounts for approximately 90% of the variance in lifetime utility. These results contrast with the work of Storesletten, Telmer, and Yaron (2004) who attributes to initial conditions only half of lifetime inequalities. Finally, in a recent paper, **?** study the same question allowing for three sources of differences across individuals: initial human capital, learning ability and financial wealth. The results demonstrate that variation in initial conditions accounts for approximately 61.5% of lifetime earnings. Unfortunately, these models lack a mechanism explaining the formation of initial conditions.
Second, an important macroeconomic literature tries to reproduce the wealth distribution using OLG models. Earlier references include Huggett1993 and Aiyagari (1994) on the role of aggregate uncertainty. Recent literature extends in two directions: allowing for productivity shocks (Krusell, Smith, and Jr., 1998) and bequest (**?**). Krusell, Smith, and Jr. (1998) make a significant contribution to the literature. They extent the basic dynastic models to allow for aggregate shocks. The motivation builds on the need to understand how the level of inequalities responds to income shocks. The model fits well the Gini index of wealth distribution. **?** provides new insights using a life cycle model with intergenerational transmission of genes and altruistic bequests. The model builds upon Heer (2001) and adopts a richer earnings process. The model fits extremely well the US wealth distribution.

However, this literature on inequalities puts a lot of effort in mimicking the wealth distribution without paying attention to the deep process that generates inequalities. To overcome this, here, the generic model of inequalities is brought with the large and growing literature that analyzes the aggregate behavior of economies with heterogeneous agents, incomplete markets, aggregate uncertainty and a realistic housing market. In this literature, Iacoviello and Pavan (2009) develop a life-cycle model with lumpy housing prices and heterogeneity in household's productivity to study the debt over life-cyle. On a more empirical side, Li and Yao (2007) construct a life-cycle model of housing tenure choice to study the impact of housing price changes on household consumption and welfare. Li, Liu, and Yao (2009) estimate a structural model of housing consumption to identify the role of different factors in the explanation of the life-cyle properties of housing. **?** analyzes the relationship between the tenure choice of an individual and the composition of its portfolio. However, the reach of this literature is limited by the absence of an endogenous price formation mechanism. An alternative modeling strategy considers housing as an additional competitive sector in dynamic stochastic general equilibrium (see e.g. Davis and Heathcote, 2005 and Fisher, 2007). Prices are derived from a construction sector. However, this literature does not consider heterogeneous locations although it is well know in urban economics, that the price of a dwelling depends on its location and the characteristics of the neighborhood it belongs to (Ioannides, 2010). As a consequence, the previous models are not able to generate static differences in housing prices over locations and heterogeneity in their evolution over time. As will be shown in the following, heterogeneous locations allow to understand simultaneously the dynamics of spatial and overall inequalities and how they are related over time.

3.2 Model

The economy analyzed in this paper is a modified version of the standard OLG model with heterogeneous agents and heterogeneous locations.[5] The key features of the model are as follows: (i) it includes a large number of households who are altruistic toward their descendants; (ii) agents are heterogeneous with respect to their age, idiosyncratic ability, human capital and wealth; (iii) households live in different locations; (iv) each location is ruled by a local government while the economy is ruled by a federal government; (v) locations are heterogeneous with respect to the level of social capital; (vi) the level of social capital affects the productivity of adults and the human capital acquisition of children; (vii) agents make mobility choice in a realistic housing market; (viii) the capital

[5]In the rest of this paper, I will assume that a household is composed of a representative adult with or without children. I use the terms "households", "agents" and "individuals" interchangeably.

market is not perfect; as a consequence, some households may be finance constrained; (ix) agents face an uninsured idiosyncratic risk of unemployment; (x) individuals inherited bequest from their parents and transmit wealth to their heirs.[6]

3.2.1 Household preferences

There is a continuum of measure 1 of agents indexed by $i \in [0;1]$ and time is discrete. Let's denote by a the age of an individual. Individuals are born at age $a = 20$, live at most T periods, work until $\tilde{T}$. θ denotes the deterministic probability to survive from age a to $a+1$. Therefore the distribution of agents over age Π_a is stationary. At birth, each agent draws its family size and the timing of the birth.

There is a large number of locations denoted $n \in \mathcal{N} \equiv \{1, \ldots, N\}$. Each neighborhood has an endogenous level of social capital denoted z. The total social capital is fixed with Π_Z being the unique invariant measure, therefore it is only its allocation over neighborhoods that changes over time.

Each household has an ability denoted $j \in \mathcal{J} \subset [\underline{J}, J]$ which is revealed at age 20. The level of human capital, specific to each household, is denoted $w \in \mathcal{W} \equiv [\underline{W}, W]$ which is acquired from age 20 to 21. The level of human capital of an agent depends on his birth neighborhood $\tilde{n}$, and his ability j.

Households receive utility from the consumption of two goods, the non-durable good and the housing services. In addition, households value the human capital and the bequest of the next generation.

A typical household chooses its housing consumption level $h \in \mathcal{H}$ in order to maximize its utility:

$$
\begin{aligned}
u(c_a, h_a, n) &= u(c_a, h_a) + \varsigma w(j^f, i_n, z_n) \qquad && \text{If a} \leq 55 \\
u(c_a, h_a) &= u(c_a, h_a) && \text{If a} > 55
\end{aligned}
$$

[6] A summary of the subsequent notations used is available in appendix.

Where ς is the parent's degree of altruism towards her children. $w(j^f, i_n, z_n)$ is the human capital acquisition function which depends on the child's ability j^f, social capital infrastructure i_n and the level of social capital z_n in neighborhood n. To reconcile the model with reality, it is assumed that for their children's human capital acquisition process, parents value the quality of their neighborhood ten years before and ten years after the birth of their children.

Such a utility function encompasses the case with no intergenerational transfer when $\varsigma = 0$. The age specific instantaneous CRRA utility corrected by family size at age a, Γ_a, is

$$u(c_{an}, h_{an}) = \frac{\left(\left(\frac{c}{\Gamma_a}\right)^{1-\sigma}\left(\frac{h}{\Gamma_a}\right)^{\sigma}\right)^{1-\gamma}}{1-\gamma} \tag{3.1}$$

Individuals can not borrow except for buying a house. The total savings of an individual is given by $-b$, and its total liability is given by b. These savings are invested into a risk-free asset which pays a gross interest $R = 1 + r$. All firms can borrow at this rate.

3.2.2 Labor Market

The specification of the labor market is similar to that in Lucas and Prescott (1974). Hence, each period, employed individuals draw a layoff probability ϑ, while unemployed workers draw a hiring probability λ. The wage rate is fixed, as a consequence the only source of heterogeneity in total wage is the level of productivity.

The household labor productivity given by l_{ajzw} can be decomposed between the contributions of: age l_a, social capital in his current neighborhood l_z, ability l_j and human capital l_w.

Let's assume that the wage per unit of labor supply is ϖ, and income is taxed at a proportional rate t_y. Hence, the individual net income is given by

$$y = e.(1 - t_y)(\varpi l_{ajzw}) + (1 - e).d \tag{3.2}$$

Where e is the labor market status, which is 1 if employed and 0 else. d is after tax unemployment benefit.

This simple specification of the labor market introduces aggregate uncertainty and the related insurance problem.

3.2.3 Housing Market

The housing supply is fixed in each neighborhood:

$$H(n) = \bar{H} \quad \forall \quad n \in N$$

Housing is a dual good: households can either rent (only consume housing services) or buy a dwelling (invest in housing and consume the housing services). The tenure is summarized by the dummy ι which is equal to 1 if the household is homeowner and 0 otherwise. Housing as an asset depreciates at rate δ_h. The real estate agencies (REA) play the intermediary role in every transaction. The introduction of the REA improves the fluidity of the housing market, and avoid waiting-list phenomenon in the housing market. In addition, we assume that only REA can be landlords i.e households can not own more than one house.

The price of a rental unit in neighborhood n is given by q_n. A selling unit in the neighborhood n is evaluated at price p_n. Owner-occupiers and landlords must respectively pay a property tax t_p and t_{pr}, while renters pay a residential tax t_r. Households can decide to adjust their housing consumption. There is no adjustment cost for renters whereas homeowners incur a transaction cost of selling τ_h which is proportional to the value of the house.

When a household wants to buy a house, she may be subject to the imperfection of the capital market. In the literature, financial constraints are introduced as a limitation in the amount an individual can borrow against his future income. Applications include Kiyotaki and Moore (1997), **?** and Iacoviello and Pavan (2009).[7] In this framework, a

[7] A household can not borrow more than its expected earnings. This is ensured by the transversality condition.

downpayment constraint is assumed

$$-b \geq \kappa p_n$$

This form of borrowing constraint is consistent with the French institutions which relies heavily on individual capacity to refund.

REA are risk-neutral and borrow at the interest rate r to buy any available dwelling. An immediate consequence of the risk neutrality of REA is that rental units consist of apartments not sold. Hence, in the most appreciated location, there is a mechanic effect that drives up the share of homeowners in the most appreciated neighborhood.

The real estate industry is competitive and pays taxes on its net income and capital gains. The perfect competition yields a zero profit condition that describes the relationship between rents and prices:

$$q_n = \left(\delta_h + t_{pr} + \frac{r}{1+r}\right) p_n - \frac{1}{1+r} E(p_{n_{t+1}} - p_n \mid n) \tag{3.3}$$

This relation defines the usage cost of an owner-occupied housing unit.

3.2.4 Production

In this economy, there is a large number of firms located in different neighborhoods. However, I assume that a representative firm exists, which maximizes its total profit. The production function is given by :

$$Y_t = F(K_t, L_t) = K_{t-1}^{\alpha} L_t^{1-\alpha} \tag{3.4}$$

where K is the aggregate capital stock and L is the stock of working efficiency labor units in the entire economy. Capital depreciates at rate δ_K. Given the aggregate consumption C, government spending G, the aggregate resource constraint is :

$$Y = C + G + K_{t+1} - (1 - \delta_K) K \tag{3.5}$$

3.2.5 Government Budget Constraint

There are two levels of governance in the model: a federal government at the economy level and a local government at the neighborhood level. Each government operates a redistribution. The federal government collects taxes on labor earnings and assets revenues to pay for unemployment benefits and the rest of the revenue is redistributed to the neighborhoods proportionally to their population size. The local government collects proportional taxes on property and renting. This cash flow allows to pay for the education infrastructure.

The objective is to not give a strategic role to the government, therefore its behavior is given.

3.2.6 Timing

Let's describe the timing of the model:

- At the beginning of the period t, a measure $(1-\theta)$ of households die
  - The heirs pay off any accidental debt and collect any bequest
- A measure θ of agents survive
  - The households decide to move or to stay. If a household decides to move, she has to sell her former housing unit h_t and chooses its tenure ι_{t+1}, its housing and goods consumption h_{t+1}, c_{t+1} and its wealth level b_{t+1}. If she decides to stay, she will choose c' and b_{t+1}
  - K_t and L_t are supplied
  - Wage, interest income and taxes are paid. Consumption and housing services are consumed
  - The neighborhood-specific job arrival rates, and job destruction rates are revealed.
- Some agents are born

  - Observe the birth neighborhood and the corresponding level of social capital z, and human capital infrastructure i^f
  - Observe its ability
  - Acquire human capital
  - Become adults the next period, and leave their parents' home.

- Some agents retire

  - The retired agents do not value anymore the level of social capital of their location. A housing adjustment may happen.

The model does not keep track of children development. It is assumed that parents value the characteristics of their location 10 years before and ten years after the birth of children. As a consequence, when young adult leave their parents home at age 21, the parents continue to value the characteristics of the neighborhood the 9 following years.[8]

3.2.7 Locational Equilibrium

In a locational equilibrium, households sort across neighborhoods along the dimensions on which they differ. In contrast to the literature on equilibrium local jurisdictions (Epple and Platt, 1998; Epple, Filimon, and Romer, 1993), the fixity of housing supply in each neighborhood induces a higher degree of stratification.

Definition: Consider a set of neighborhoods, $n = 1, \ldots, N$. An allocation of households across neighborhoods is an equilibrium only if:

1. The static housing choices are optimal i.e each household maximizes its housing consumption subject to the budget constraint.

2. The local housing markets clear.

[8]It is assumed that agents are born at age 20 and become adult after one year. This assumption simplifies the dimension of the state variables and avoids to keep track of households over a long period of time. However, this simplification is not realistic. As a consequence, It is assumed that parents value the characteristics of the location 10 years before the birth of the children and 10 after this birth.

3.2.8 The Household Problem

At period t, the set of individual state variables is: w_t the household human capital, j_t its ability, z_t the level of social capital of the neighborhood it belongs to, b_{t-1} the nonhousing wealth or debt, h_{t-1} the housing stock owned former period, ι_{t-1} for tenure, e_t for the labor market status and a_t for age. Let's denote by $s_t \equiv (a_t, w_t, j_t, e_t, z_{t-1}, b_{t-1}, h_{t-1}, \iota_{t-1})$.

Given initial condition, the household problem is to make a set of two choices: a mobility decision (move or stay), a tenure choice (rent or own).

Th dynamic problem of an agent with state variables s_t is:

$$V(s,\beta) \quad = \quad max\{V^s(s_t,\beta), \underset{z}{sup}\{V^{mr}(s_t,\beta)\}, \underset{z}{sup}\{V^{mh}(s_t,\beta)\}\}$$

under the constraint of the total resources of household b^t. V^s, V^{mr} and V^{mh} are respectively the value function if an agent stays, rents after a mobility and owns after a mobility.

3.2.8.1 The value of staying

An individual who decides to stay in its current housing unit can not adjust its consumption of housing. As a consequence, the choice set is reduced to consumption and saving. The value of staying is the solution to the following problem:

$$\begin{aligned}
&V^{s_t}(s_t,\beta) = \underset{c_t,b_t}{sup} \quad u(c,h,a) + \theta_a \beta E[V(s_{t+1},\beta)] \\
&\text{s.t.} \quad y_t + b_t - [rb_{t-1}(1 + t_{ib_{t-1}\geq 0}]) \geq c_t + \Big[\iota[p_{nt}(t_p)] + (1-\iota)[q_n(1+t_r)]\Big] h_t \\
&\qquad c_t \geq 0; \qquad h_t \geq 0
\end{aligned}$$

Where $ib_{t-1} \geq 0$ is a dummy indicating that the household had savings.

When an individual decides to move, she has to choose the location that maximizes its utility under its resource constraint. The index of the current location is n_t, while the next location is given by n_{t+1}.

3.2.8.2 The value of moving and renting

The value of moving and renting is the solution to the following problem:

$$\begin{aligned}
V^{mr}(s_t,\beta) &= \sup_{c_t,h_t,b_t,z_t} \quad u(c_t,h_t,a) + \theta_a\beta E[V(s_{t+1},\beta)] \\
\text{s.t.} \quad & y_t + b_t - [rb_{t-1}(1+t_{ib_{t-1}\geq 0}]) + \iota_{t-1}\left[(1-\tau_h)(1-\delta_H)p_{n_{t-1}}h_{t-1}\right] \geq c_t + \left[q_n(1+t_{rn})\right]h_t \\
& c_t \geq 0; \quad h_t \geq 0
\end{aligned}$$

3.2.8.3 The value of moving and owning

Finally, the value of moving and owning is the solution to the following problem:

$$\begin{aligned}
V^{mr}(s_t,\beta) &= \sup_{c_t,h_t,b_t,z_t} \quad u(c_t,h_t,a) + \theta_a\beta E[V(s_{t+1},\beta)] \\
\text{s.t.} \quad & y_t + b_t - [rb_{t-1}(1+t_{ib_{t-1}\geq 0}]) + \iota_{t-1}\left[(1-\tau_h)(1-\delta_H)p_{n_{t-1}}h_{t-1}\right] \geq c_t + \iota_t\left[p_{n_t}(1+t_{p_{n_t}})\right]h_t \\
& b \geq (1-\kappa)p_{n_t}h_t \\
& c_t \geq 0; \qquad h_t \geq 0
\end{aligned}$$

3.2.9 Bequest Motives

Until now, an explicit bequest motive was not allowed. That is, any accidental bequest was collected by the local government. In this section, a motive for bequest is introduced. The main complication comes from the fact that it adds another term to the value function. Let's illustrate this using the value function of staying.

$$V^s(s_t, \beta) = \sup_{c_t, b_t} \quad u(c_t, h_t, a) + \theta_a \beta E[V(s_{t+1})] + (1-\theta_a)\varsigma\psi(b_{t+1} + \iota(p_{n_{t+1}} \cdot h_t) \tag{3.6}$$

With all these concepts at hand, it is now possible to define an equilibrium.

3.2.10 Competitive Recursive Equilibrium

A recursive competitive equilibrium is a set of value functions $\{V(s_t, \beta)\}$, policy functions for the mobility decision $\{S^*(s_t, \beta)$, the saving decision $B^*(s_t, \beta)\}$, the tenure choice $\iota^*(s_t, \beta)$, the level of social capital $Z^*(s_t, \beta)$, the consumption $C^*(s_t, \beta)$, and the wage rate $\varpi^*(s_t, \beta)$ for each age and aggregate variables K_t, L_t, H_t^h, G_t , level of taxes $\{t_y\}, \{t_i\}, \{t_p\}, \{t_r\}$, prices p_{nt}, q_{nt} for each period t, and the joint distribution of all states Φ such that:

1. The locational equilibrium holds with respect to its former definition.

2. Given the housing prices in each neighborhood (q_{nt} , p_{nt}), the wage rate ϖ_t and the laws of motion (π^K, π^L): K^* and L^* are determined competitively at any t

$$r^* + \delta_k = F_K(K^*, L^*) \tag{3.7}$$

$$\varpi^* = F_L(K^*, L^*) \tag{3.8}$$

3. The unemployment rate is stationary, and the labor supply equals:

$$L^* = \int l_{ajzw}(z, \beta) d\Phi_t(a, e, n, j, b_{t-1}, h_{t-1}, z_{t-1}) \tag{3.9}$$

4. The asset market clears at any t

$$K^* = \int b^* + \Big([1-\iota^*]q_{n^*}^* - \big[1 - t_p - \tau_h - \delta_h\big] p_{n^*}^*\Big) h^* d\Phi_t(a, e, n, j, b_{t-1}, h_{t-1}, z_{t-1}) \tag{3.10}$$

5. The distribution of bequest is stationary.

6. The rental price is given by the no-arbitrage condition in the real estate sector

$$q^*_{n^*} = \left(\delta_h + t_p + \frac{r^*}{1+r^*}\right) - \frac{1}{1+r^*} E(p^*_{n_t} - p^*_{n_{t-1}} \mid n) \tag{3.11}$$

7. The housing market clears in every neighborhood

$$\bar{H} = H(n) = \int h^*_n d\Phi_t(a, e, n, j, b_{t-1}, h_{t-1}, z_{t-1}) \tag{3.12}$$

8. The federal and local governments budgets constraint hold

$$G^*_F = t_y \varpi^* L^* + \int \Big(t_i r^* b^* - d\Big) d\Phi_t(a, e, n, j, b_{t-1}, h_{t-1}, z_{t-1}) \tag{3.13}$$

$$G^*_L = \frac{1}{N} G^*_F + \int \Big(\iota h^* p^*_{n^*} t_p + (1-\iota) h^* q^*_{n^*} t_r\Big) d\Phi_t(a, e, n, j, b_{t-1}, h_{t-1}, z_{t-1}) \tag{3.14}$$

9. The distribution of the state variables $\Phi_t(a, e, n, j, b_{t-1}, h_{t-1}, z_{t-1})$ is stationary.

3.2.11 Solution Method

The model has no analytical solution, thus I follow the literature and solve it numerically like Heer (2001). However, there are some issues linked to the housing dimension and differences across neighborhoods. The most important one is the level of prices which is endogenous. Since there is no aggregate production shocks, and we focus on the steady state of the model, the major computation issue of the model comes from the housing prices. The solution algorithm tries to derive for each neighborhood a sequence of prices that equalizes demand and supply every period. The general solution algorithm for the model consists of the following steps:

Step 1: Make initial guesses of steady state values of the aggregate labor supply L and the aggregate capital K.

Step 2: Guess an initial level of housing prices in every neighborhood and the corresponding rental price

Step 3: Given housing prices, labor productivity, and interest rate, compute the optimal decision functions by tenure, employment status, income levels, portfolio composition in each neighborhood

Step 4: Iterate backward in time $t = T_{c-1}, \ldots, 1$ and recover the sequence of housing prices and policy functions.

Step 5: Compute the optimal path for human capital investment, consumption, saving, employment, residential choices for the new-born generation.

Step 6: Compute the steady-state distribution of assets and bequests in each cohort-neighborhood

Step 7: Compute the aggregate capital stock K and Labor supply L

Step 8: Update K and L and return to step 3 until convergence

Before the first step, an optimal time horizon T_c, which is 300 years.

In step 3 and 4, a finite-time dynamic program is solved by iterating the policy functions of generation t backward starting in the last period. The policy functions are computed from the Euler equation for each type of agents over a discrete grid. I can determine the optimal decision for period t given period $t+1$ optimal controls in grid points. I use a cubic spline interpolation technique in order to get optimal decisions.

At step 6, the distributions of assets and bequests are recovered using the preceding values. I start the computation of the model based on data from the 1990 census, and iterate until reaching a steady state. I made an assessment of the model based on census data available in 1999, then I present the result derived from equilibrium.[9]

[9]The solution of the model is very demanding in terms of computation. It takes 15 days CPU time on a Unix Workstation.

3.3 Data

The agents and the locations are heterogeneous along a large number of dimensions. I use the 1990 and 1999 French population censuses to characterize them. The population census contains extensive information about employment, household composition, education, geographical location for one fourth of the population. The sample size allows to compute the precise individual characteristics at the suitable geographical level and provides a full picture of the housing market. In the empirical analysis, a neighborhood is an IRIS, the French equivalent to the US census blocks.

Using two samples allows to construct a mobility matrix between locations over a period of 10 years. A notable limitation of the French census is the absence of financial information. That is, wealth, income and housing prices are missing. The following strategy is used. First, the distribution of income (moments) over space can be obtained from an administrative source, Revenus Fiscaux des Menages. This distribution can be computed at the finest geographical level (IRIS). Then, the first two moments (mean and standard deviation) can be used to draw an income for each household depending on its neighborhood.

The information about wealth comes from two wealth surveys: Actifs 92 and Patrimoine 2004.[10] However, the limited sample size per neighborhood does not allow to characterize the full distribution of assets. To overcome this, I assume that the distribution of wealth across and within a neighborhood is three times as volatile as the income distribution.

Finally, housing prices data comes from the 1992, 1996 and 2002 French Housing surveys. A mean price by square meter is computed for each transaction. However, the number of neighborhoods present in the two samples is limited. In the final sample, only 1,006 neighborhoods with all the required variables are considered. These neighborhoods are located in the 30 biggest French metropolitan areas. In order to reduce the computational burden, only a fifth of the 1999 census data is considered. This yields a

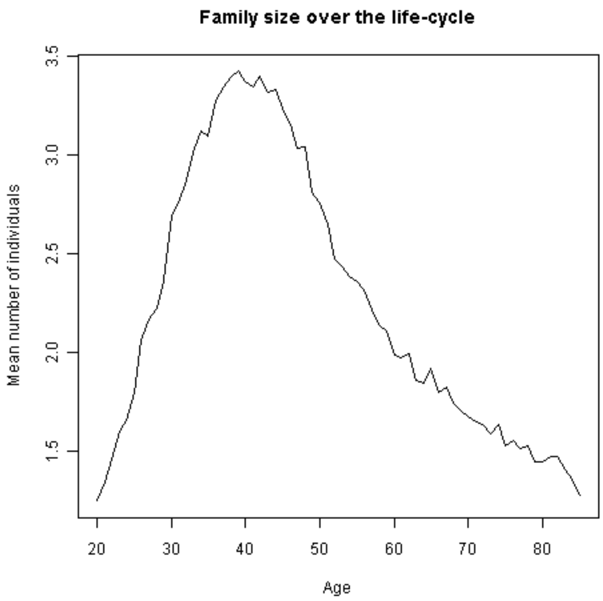
[10]Since 1986, the French Statistical Office (INSEE) have carried out a survey on Wealth every six years. It was called Actifs Financiers until 1992, before becoming Enquete Patrimoine in 1998.

total sample size of 500,588 individuals with the neighborhood population ranging from 290 to 1,106.

3.3.1 Descriptive Evidence

I start by describing the life-cycle dimension of the basic variables. Let's start by family size over the life-cycle using the 1999 census.

Figure 3.1: Family size over the life cycle

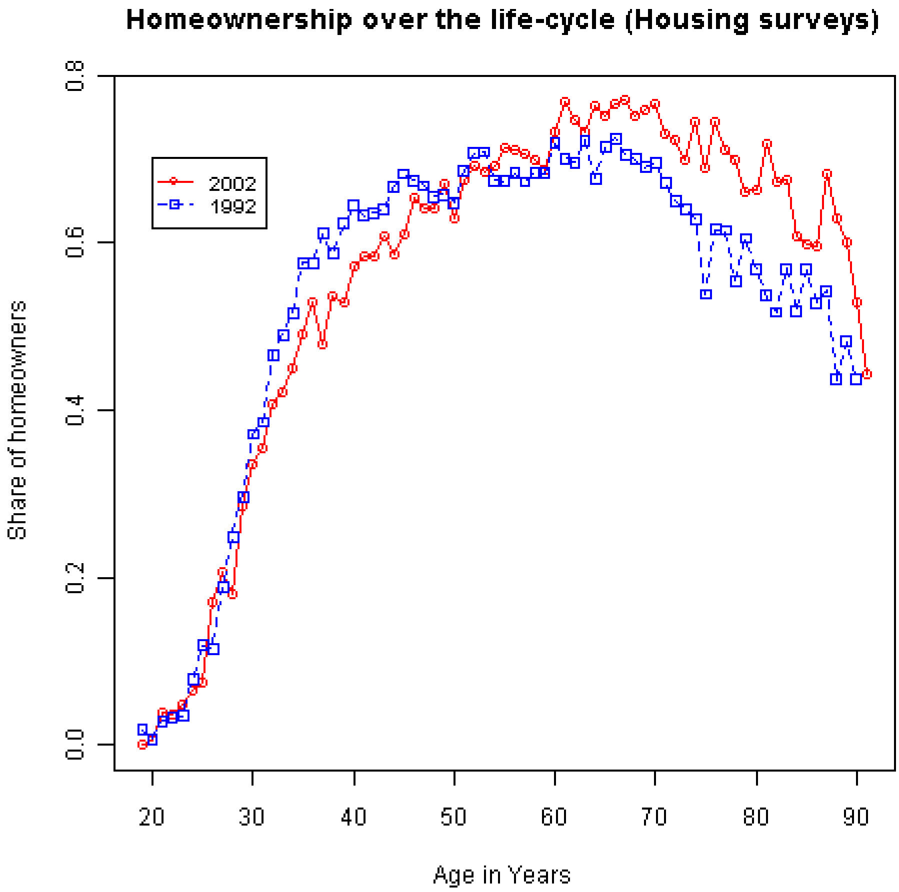


As expected, the family size follows an inverse U shape that is consistent with the patterns of family composition over the life-cycle. The family size reaches its maximum size around 40 years, and then decreases.

It is now insightful to look at the similarities between family size and homeownership. The Figure 3.2 plots the rate of homeownership as a function of age.

The share of homeowners in the population increased from 53.8% in 1992 to 56.0% in 2002. This rise is driven by the persistence of a high homeownership rate for individuals older than 60. However, Figure 3.2 missed the decrease in the flow of new homeowners that started after 1996.

Figure 3.2: Homeownership over the life-cycle (Housing Surveys)

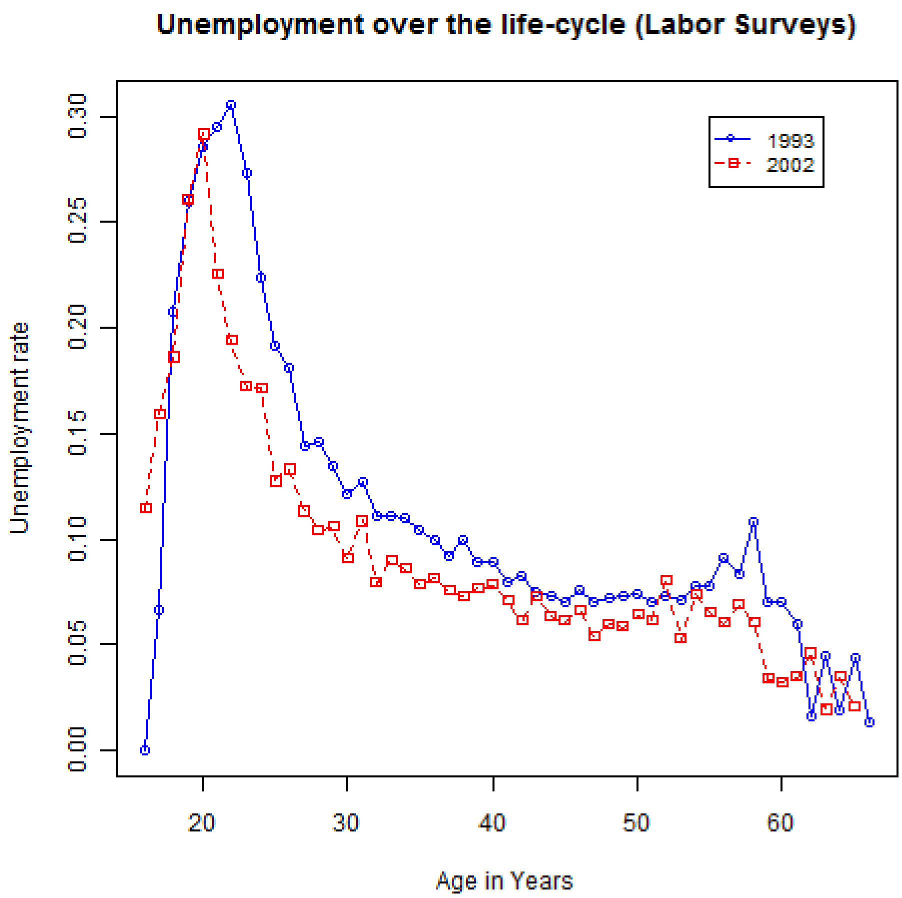


Regarding the labor market, Figure 3.3 plots the unemployment rate over the life-cycle in 1992 and 2002. I record an unemployment rate of 10.5 % in 1993, and 8 % in 2002. The differences between the two distributions reflect this discrepancy.

The distribution of housing wealth over the life-cycle is now analyzed. There is a large discrepancy between the housing stock detained by French households over the period from 1992 to 2004. The most plausible explanation is related to the increase in the general level of prices. [11]

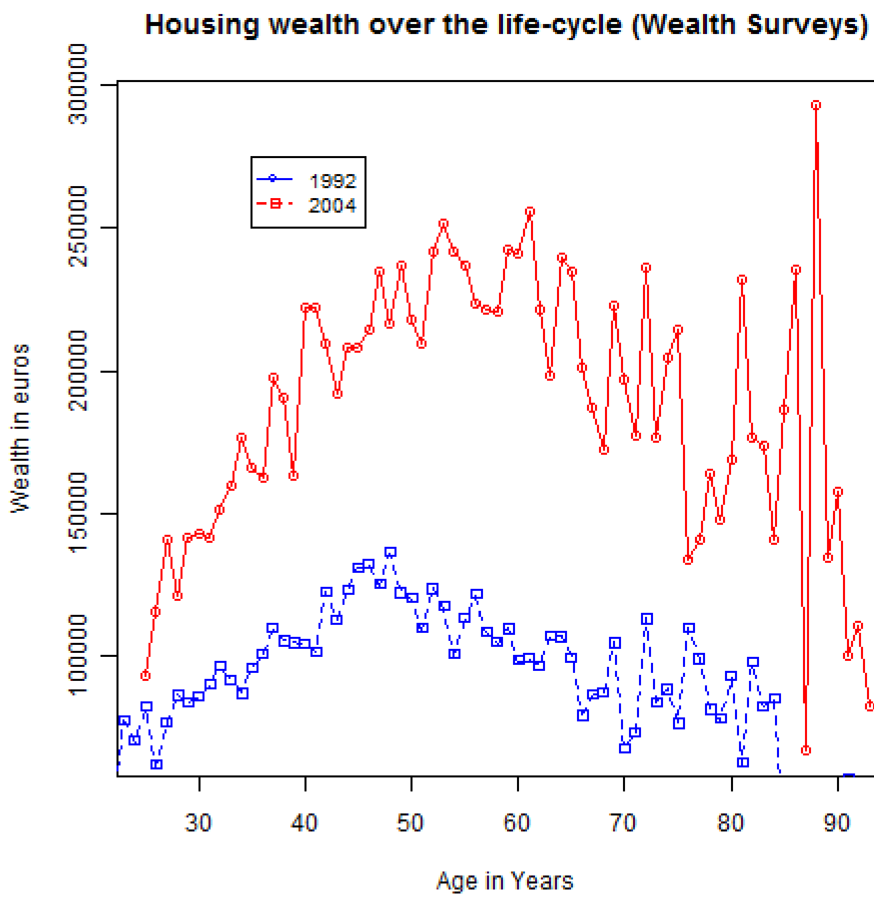
[11] Because of the small sample size, the data shows several inconsistent spikes.

Figure 3.3: Unemployment over the life-cycle (Labor Surveys)



Some basic facts about intergenerational transfers are documented based on the wealth surveys 1992 and 2004. There is a large discrepancy between the transmission behavior in 1992 and 2004. That is, only 5% of the households perceived a donation in 1992, while the rate is close to 20% in 2004. The same holds for inheritance, only 18% of households declared an inheritance in 1992, while the rate is close to 40% in 2004. These discrepancies may reflect changes in the thresholds for the taxation of inheritance. In terms of amount, it is complicated to provide a comparison over time since the amount are presented by ranges, and the categories are not constant over time. To overcome this, the more homogeneous 1998 and 2004 Wealth surveys are used to provide some facts

Figure 3.4: Housing wealth over the life cycle (Wealth Surveys)



about generational transfers. Table 3.1 shows the evolution of the share of bequest in individual wealth. For more than half of the population, 60.3% in 1998 and 58.3 % in 2004, there has been no inheritance yet. Two important facts need to be pointed out in terms of dynamics. First, the share of individuals who did not benefit from inheritance or did not inherit a negligible amount decreases over time while the share of individuals who benefit from a substantial share of their total wealth increases.

Data are completed with the findings of **?** who reports around 10% of national wealth transferred across generations. These transmissions are not uniformly distributed. In

Table 3.1: Share of inheritance between 1998 and 2004

Share	1998	2004
No inheritance	60.3	58.3
Null	8.6	7.7
Less than 25 %	18.2	18.5
From 25 to 50%	6.7	7.4
More than 50%	5.5	6.8

Notes: Sources: Patrimoine 1998, 2004. Number of observations: 10,207 in 1998 9,239 in 2004

Table 3.2: Descriptive Statistics over neighborhoods (Census 1999 and 2002 Housing Survey)

	Minimum	Mean	Sd	Maximum
Share of homeowners	1.2	49.7	19.6	95.2
Share of unemployed	4.2	12.1	5.7	50.2
Share of individuals with no degree	2.3	13.1	6.8	43.2
Share of individuals with college education	1.1	9.9	2.8	17.2
Price by square meter in 2002 in €	249.5	1,542	831	9,147

Notes: Sources: Census 1999, Housing Survey. The analysis uses the observations from the 30 biggest metropolitan areas.

1994, the top 10% generational transmissions represented 55% of the total transfers across generations.

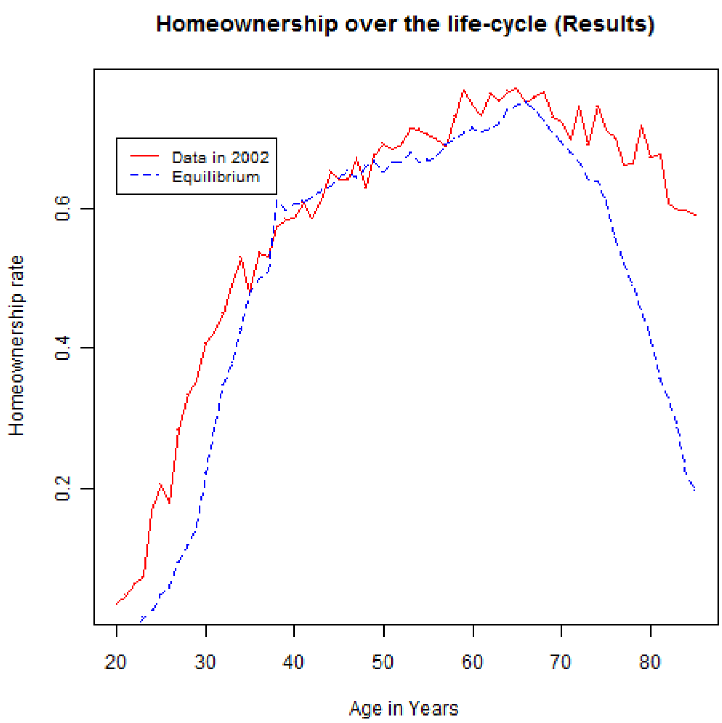
After having described the life-cycle dimension, the distribution of some basic characteristics over space can be analyzed.

Both homeownership and unemployment rates are very spread across locations. Table **??** reports the distributions. More surprisingly, given the existence of mandatory education in France, the level of individuals with no degree per neighborhood is also very spread moving 2.3% to 43.2% revealing a high level of sorting. Finally, the level of housing prices ranges from 249.5 € in the municipality of Denain in the North of France to 9,147 € in the 7^{th} district of Paris.

3.4 Results

In the model, the households choose consumption, saving and make residential choices. I consider for now the model when individuals do not have a bequest motive i.e any bequest is collected by the local government. As displayed in Figure 3.5, the model fits until age 65, and does not perform well in predicting the homeownership rate after retirement. Indeed, agents over consume both goods and housing services without holding any housing asset. This is due to the fact that the prospective increase in price combined with the lower usage cost of homeownership does not compensate for the level of transaction and maintenance costs.

Figure 3.5: Homeownership over the life cycle (Results)



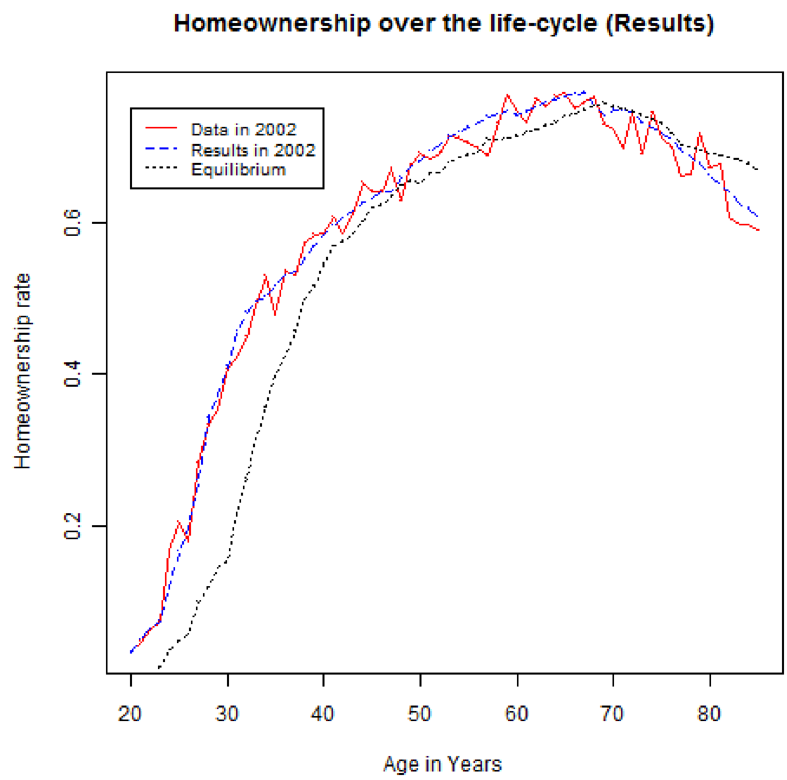
Instead of recalibrating the parameters, I move directly to the model where agents have a bequest motive which provides much more interesting results.

3.4.1 Homeownership Over The Life-cycle

The model fits extremely well the homeownership rate over the life-cycle. In 2002, the model predicts an homeownership rate of 54.6% to be compared to 54.2% in the data. According to the analysis, the equilibrium homeownership rate is approximately

50.2% which is substantially lower than the last available homeownership rate, 57.8% in 2009. Moreover, the homeownership rate has been increasing since the early 2000. As a consequence, the housing market may be running on a disequilibrium path.[12] The effect of the predicted slowdown in the homeownership rate is not uniform across life-cycle. Indeed, the equilibrium homeownership rate is almost always lower than in the data except for the range of ages higher than 70. The presence of bequest plays a decisive role in generating this result as explained in the preceding section.

Figure 3.6: Homeownership over the life cycle (Results)



[12]Our model does not include the favorable institutional environment set up to promote homeownership after 1996. A free interest rate loan was set up in 1996 for low-income household.

3.4.2 Prices and Social Capital over Locations

Prices and the level of social capital in equilibrium are now analyzed. Figure 3.7 displays the equilibrium prices (in 1/K €) and level of social capital against their values in the data. In equilibrium, both the level of prices and social capital are much more spread to the right than in the data. This indicates a higher dispersion, and a widening of inequalities across neighborhoods.

Figure 3.7: Nonparametric density of the distributions of prices and social capital

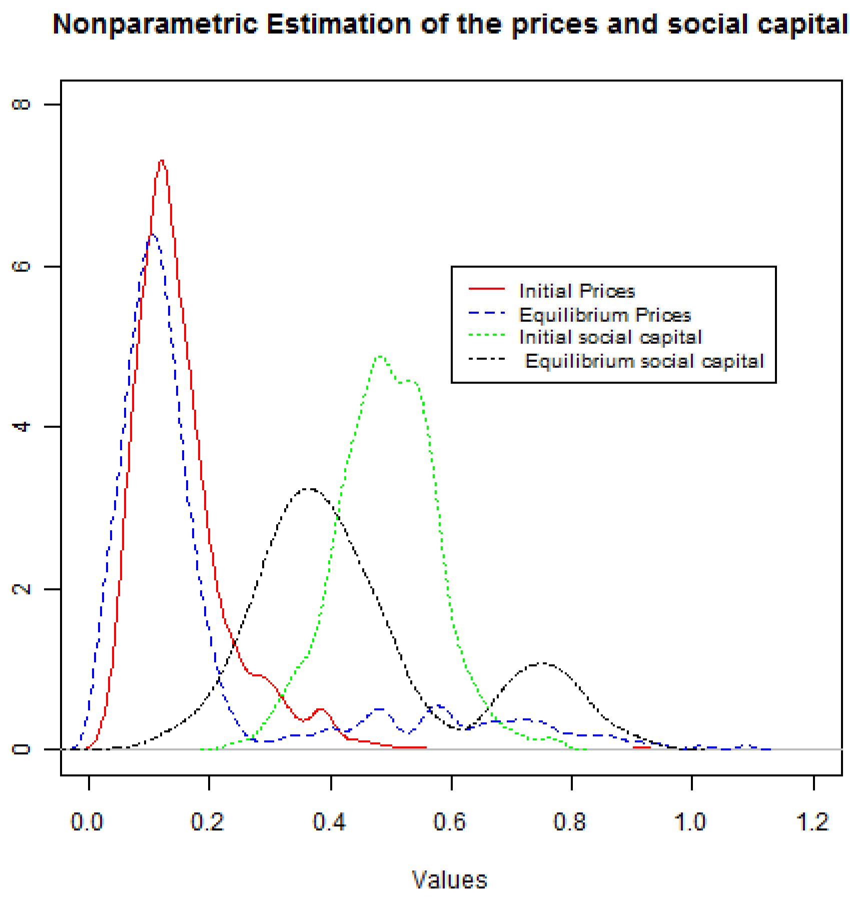


Table 3.3 reports the moments of the former distributions. Equilibrium and initial prices display strong distributional differences. The first quarter and the median of the equilibrium prices are respectively 0.08 and 0.12 whereas these quantiles are equal to

0.10 and 0.13 in the data. The large dispersion of the equilibrium prices yields a standard deviation of 0.21 to be compared to 0.08 in the data.

Table 3.3: Prices and social capital distributions

	Moments and Quantiles						
	Min	1^{st} Qu.	Median	Mean	Std dev.	$3^{rd}Qu.$	Max
Price (Data)	0.0249	0.1001	0.1343	0.1542	0.0831	0.1829	0.9147
Prices (Equilibrium)	0.2011	0.0828	0.1205	0.2015	0.2119	0.1832	1.090
Social capital (Data)	0.2397	0.4381	0.4909	0.4932	0.0826	0.5473	0.7712
Social capital (Equilibrium)	0.0504	0.3250	0.4008	0.4464	0.1787	0.5088	0.9346

The same shift happens with the level of social capital. As a consequence, the equilibrium relation between prices and the level of social capital exhibits stronger correlation than in the initial period. That is, the initial correlation that the model matched was around 0.17 whereas in equilibrium, correlation is approximately 0.76. To sum up, there is a higher level of price discrimination in equilibrium. The related mechanism is driven by the competition for the best neighborhoods which drives up the level of prices. This leads to the concentration of characteristics positively correlated to social capital in the best locations. This self-enforcing mechanism is the main determinant of these results. This result in terms of sorting reflects the equilibrium of the model, and are derived from the initial conditions provided by data.

3.4.3 Unemployment Over The Life-cycle And Between Locations

The outcome of the model in terms of unemployment is shown in Figure 3.8. The calibration of the job offer rate assumes skill-specific job arrival rate. The model fits very well the unemployment rate over the life cycle. However, there are some distributional differences between the simulated equilibrium and the data. In equilibrium, the unemployment rate is much lower for young people (less than 30 years) than in the data. Conversely, the equilibrium unemployment rate is higher for individuals between 60 and 65 years old than in the data. This result is driven by the dynamics of inequalities. As disparities across individuals and locations widen, the job arrival rate for this class of individuals, which was low in our baseline calibration, does not adjust. As a consequence, the unemployment rate increases. Table 3.4 summarizes the differences between locations. An unforeseen outcome is related to the highly polarized distribution of unemployment. While in the data, only 5 neighborhoods have an unemployment rate lower than 5%, in equilibrium, there are 122 such neighborhoods. Likewise, only 3 neighborhoods in the data have an unemployment rate higher than 40% whereas in equilibrium there are 141 neighborhoods in this case. The increase in the disparities between neighborhoods is explained by the high segmentation according to the level of social capital.

Figure 3.8: Unemployment over the life cycle (Results)

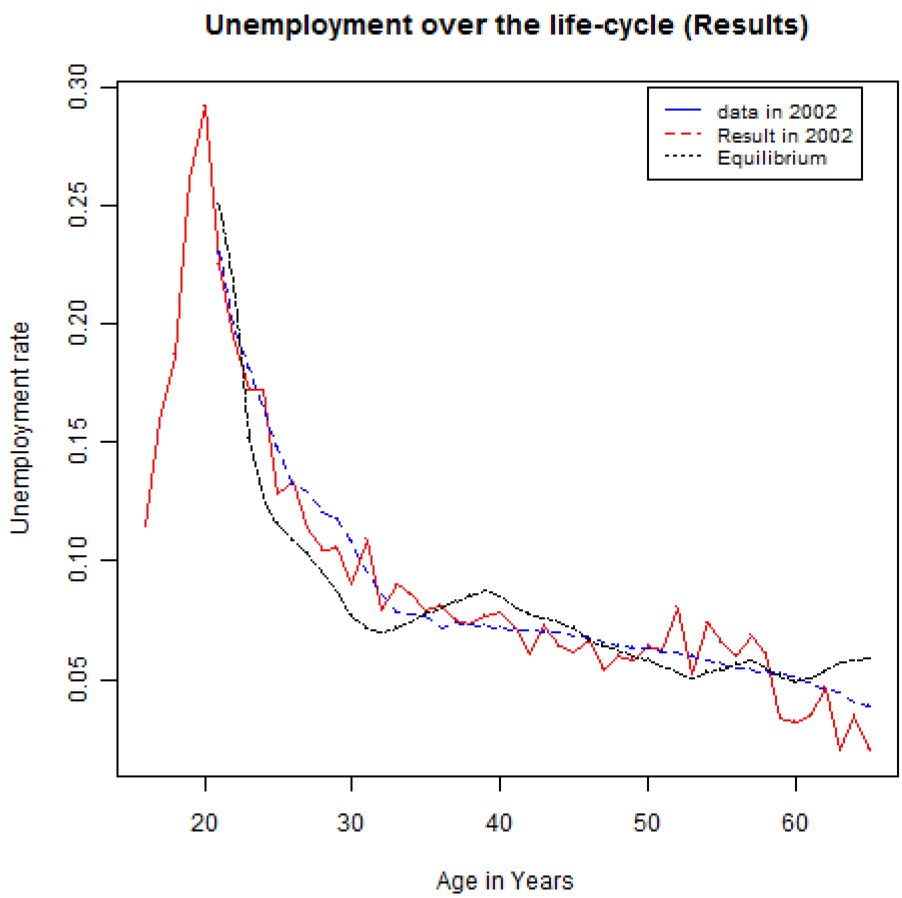
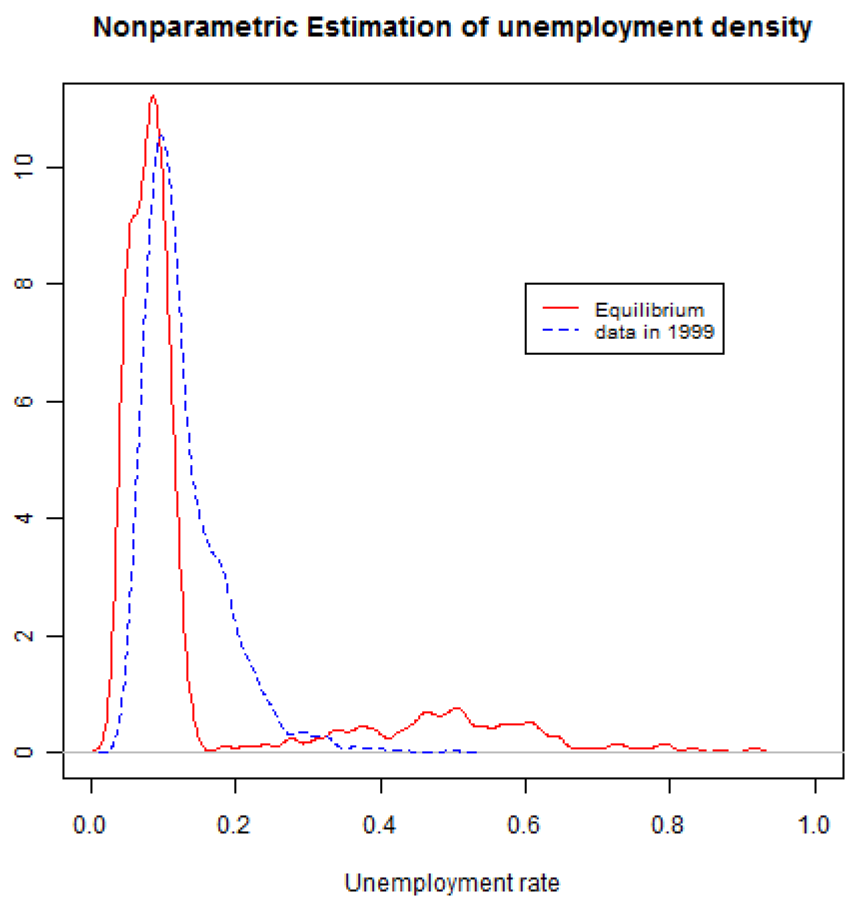


Table 3.4: Unemployment per age and locations

	Moments and Quantiles						
	Min	1^{st} Qu.	Median	Mean	Std dev.	$3^{rd}Qu.$	Max
Local Unemployment (Data)	0.0422	0.0891	0.1119	0.1276	0.0575	0.1529	0.4981
Local Unemployment (Model)	0.0119	0.0633	0.0878	0.1595	0.1773	0.1160	0.9204

The former results are confirmed by the nonparametric estimation of the distribution of unemployment over locations. Two pieces of evidence can be drawn from Figure 3.9. On one hand, the distribution presents a spike at a very low unemployment rate, around 4%. On the other hand, another peak of a smaller magnitude takes place around 50%.

Figure 3.9: Nonparametric density of unemployment rates over locations



3.4.4 Wealth and Intergenerational Link

This section is devoted to the intergenerational link. Table 3.5, reports the characteristics of individuals at the bottom and the top of the wealth distribution. The ultimate goal is to examine the contribution of differences across generations, individuals and locations into overall inequalities.

On one hand, the individuals at the bottom of the wealth distribution have hardly inherited 1% of their current wealth. Basically, these individuals have a tiny level of wealth, as a consequence, the amount of bequest is negligible. However, there is a great deal of endogeneity explaining this outcome. Due to the low level of social capital in their birth location, several individuals do not get a high education. As a consequence, their prospect in the labor market and in terms of wealth accumulation are slim. On the other hand, the richest individuals have a high share of bequest in their wealth. Bequests account for 88% of the wealth of the individuals in the top percentile. These individuals have a lower level of education and ability than their counterpart belonging to the 10% and 5% percentiles. Overall, differences in the level of social capital in the birth neighborhood explain a substantial part of inequalities over generations.

Table 3.5: Wealth distribution, inheritance and individual characteristics

	Bottom 1%	Bottom 5%	Bottom 10%	Top 10%	Top 5%	Top 1%
Inheritance (%)	0.2	0.7	1.2	69	81	88
Ability	0.44	0.56	0.60	0.73	0.61	0.58
Education	9.1	12.3	13.4	17.6	15.8	15.2
Social capital	0.09	0.12	0.16	0.55	0.76	0.87
Social capital at birth	0.07	0.13	0.15	0.49	0.59	0.89

Another implication of the model is related to intergenerational mobility. Basically, individuals at the bottom of the wealth distribution, are those with the lowest social capital at birth. In equilibrium, 21.3% of individuals live in a better neighborhood than their parents at retirement age. This suggests a much lower rate of intergenerational mobility than in the study of Blanden et al. (2002) who estimate this ratio to be around 60% in the UK. Even if they do not report results for France, one could expect an intergenerational mobility at least similar to the one in the UK. Given the current trends in wealth concentration, the results bring new light into the long-term consequences of such a phenomenon.

3.5 Extensions and Experiments

3.5.1 Extensions

At this point, lifetime inequality is decomposed between individuals, locations and generational components. The model is simulated with a single source of heterogeneity at a time. I start with a cohort of individuals born in the same neighborhood and who receive later the same amount of bequest. Ability is the only source of heterogeneity in this case.[13] Then, I simulate a cohort of homogeneous individuals in terms of ability and born in the same location. The only source of heterogeneity is the amount of bequest. Finally, the differences in the level of social capital are analyzed. Using these three simulations, the lifetime inequality can be decomposed over the contributions of individuals differences, initial endowment and locations heterogeneity. This simulation exercise used a sample of 100,000 with all the source of inequality distributed as in the steady state of the model.

In the long-run, bequest and spatial inequalities account for approximately 80% of lifetime inequalities. Heterogeneity in individual ability accounts for around 18.2%, while bequest represents 55% of wealth inequalities. Unfortunately, there is to my knowledge no paper in the literature with the same sources of inequalities that could be used as a benchmark for comparison.

These results shed new light on the dynamics of inequalities. In the recent period, several reports demonstrate that wealth disparities across individuals have widened. For example, the 2010 French Wealth Survey reports that the discrepancy in wealth between the top 10% and the bottom 10% of households has increased by 35% from

[13]The individual component of inequality could have been measured using the level of education. However, since education depends on the level of social capital of the birth neighborhood, it is more suitable to use the idiosyncratic ability.

2004 to 2010 with housing prices as the main driving force. In a context of widening inequalities between generations and locations, we show clearly that in the long run the major determinants of inequalities are bequest and differences across locations.

Table 3.6: The decomposition of wealth inequalities

	Ability	Bequest	Social Capital	Education
After 10 years	52.3	8.5	40.2	62.4
After 20 years	38.1	25.2	36.7	48.9
After 30 years	29.9	36.5	33.6	42.3
After 40 years	25.1	44.3	29.6	36.8
After 50 years	18.2	55.0	26.8	31.5

3.5.2 Experiments

After having highlighted the importance of bequest and spatial inequalities in the differences across individuals, the effects of some policies on overall inequalities is simulated. These policies are based on institutional measures and taxes. In the first experiment, the borrowing constraints are relaxed. In the second, bequest taxation is imposed. Finally, the last experiment implements a policy against income segregation that will constraint every neighborhood to have a diverse population in terms of education.[14]

3.5.2.1 No borrowing constraints

There are several potential channels under which borrowing constraints could affect the behavior of agents. The most obvious one is related to the homeownership decision. Several other channels exist. First, the borrowing constraint of the parents can affect the level of education of the children. Second, it can delay the homeownership decision of the young individuals and prevent them from living in the best neighborhoods. The results shows that all these channels are effective. First, there is a substantial effect on homeownership. The mean homeownership rate without borrowing constraint is around 62% to be compared to 54% in the presence of borrowing constraint. This effect

[14]I use interchangeably the terms melting pot, urban mix, diversity to refer to the policy against

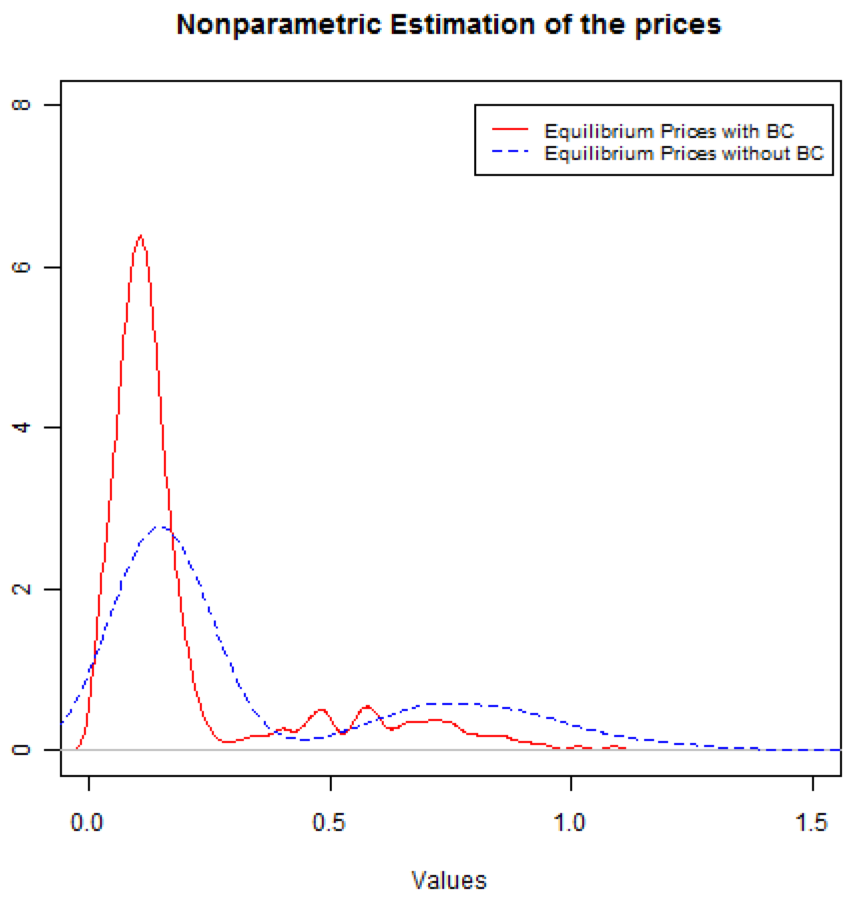
Table 3.7: The effects of borrowing constraints

	Age distribution						
Outcomes	21-30	31-35	36-40	41-45	46-50	51-64	65 +
	With Borrowing Constraints						
Homeownership	6.8	31.1	48.8	58.9	64.2	67.6	71.7
Education	13.9						
Social capital	0.21	0.33	0.39	0.42	0.46	0.53	0.47
	Without Borrowing Constraints						
Homeownership	15.8	34.6	52.1	60.9	67.5	70.2	74.8
Education	14.2						
Social capital	0.23	0.32	0.41	0.44	0.47	0.52	0.45

holds for the younger generations. It increases also both the mean and the dispersion of housing wealth in the population. In fact, an indirect consequence of relaxing borrowing constraints is on the level of prices. As shown in Figure 3.10, the equilibrium distribution of prices is much more spread on the right with the mean price moving from 2015 € per square meter in the model with borrowing constraints to more than 3400 € per square meter when borrowing constraints are relaxed. This sharp increase is mainly due to the highly inelastic demand for the best neighborhoods. As a consequence, the number of neighborhoods with a mean price higher than 5,000 € per square meter increases substantially from 126 to 280.

Additional implications are in terms of social capital and education. There is a small distributional effect on the level of social capital of the youngest agents, allowing them to buy in better neighborhoods than what they could do otherwise. Finally, borrowing constraints have an effect on the distribution of education. The mechanism is related to the increase in the level of housing prices which yields higher tax revenues for the government. The consequence is an appreciation in the level of human capital acquisition infrastructure. The mean education rate increases from 13.9 to 14.2. However, this effect holds only for the inhabitants of the neighborhoods with the highest level of social capital. To sum up, relaxing borrowing constraints is effective in helping young individuals achieving homeownership. However, because of several undesirable consequences (prices, education), the net effect on well-being is not clear.

Figure 3.10: Nonparametric density of the price distribution



3.5.2.2 Bequest taxation

The introduction of a tax on bequest has an important impact of the wealth transmission behavior of agents. It should be noted that the effect is highly dependent of the taxation rate. A taxation of 100% is similar to the model with no bequest. The results are similar but of smaller magnitude for the range of taxation rates higher than 60%. These levels of taxation act as a disincentive to wealth accumulation and transmission, but provide more resources to the local governments. Since, the majority of bequests happens in the best neighborhoods, the ultimate consequence is to increase disparities across locations via the education institutions which are financed by local tax revenues.[15] A potential solution would be to assign the bequest to the federal government. This solution creates a better redistribution and increases the mean educational level. Still, there are lot of inefficiencies due to overconsumption after retirement.

The most interesting cases occur for a taxation rate between 10 to 30%. There is still overconsumption, but of a smaller magnitude, and the induced mobility stabilized both the level of price and the homeownership rate. Table 3.8 reports the distributions of the share of inheritance, ability and education of individuals located in the tail of the wealth distribution. The effect of age is accounted for by using a cohort of individuals.

A comparison between these numbers with those Table 3.5 demonstrates that the mean educational level and the mean ability level of the most wealthy individuals tend to increase, highlighting the shift toward a society more fair and the decreasing role inheritance in inequalities.

The mean level of education is highly dispersed across taxation rates. The minimum level of education tends to increase with the level of taxation as one would have expected since education is financed by local tax revenues. However, since the model assumes stationarity in the level of social capital, and given its importance in education, the assumption prevents the mean education from increasing over time. The share of inheritance in total wealth decreases substantially with higher taxation rate, particularly for the most wealthy individuals. This decrease is compensated by a higher share of highly educated individuals. However, since the level of social capital of the birth location is a determinant of the level of education, there is still a persistent component in the level of inequalities.

[15] After retirement, the location of an individual has no impact on its well-being. As a consequence, the high rate of bequest taxation drives to a large share of individuals selling their home in the best neighborhoods and renting in the cheapest ones. These individuals over-consume both housing services and consumption and end up with a small amount of wealth.

Table 3.8: Wealth distribution, inheritance and individual characteristics

Taxation Rate		Top and Bottom groups (Percentile)					
		Bottom 1%	Bottom 5%	Bottom 10%	Top 10%	Top 5%	Top 1%
10 %	Inheritance [0:100]	0.1	0.6	0.9	56	69	76
	Ability [0:1]	0.43	0.58	0.63	0.76	0.67	0.61
	Education [9:20]	11.4	13.2	13.1	18.5	17.7	16.8
15 %	Inheritance	0.1	0.5	0.8	45	51	63
	Ability	0.44	0.57	0.68	0.76	0.70	0.66
	Education	11.4	12.9	13.7	17.6	17.4	17.5
20 %	Inheritance	0.1	0.4	0.8	40	46	57
	Ability	0.41	0.49	0.58	0.79	0.72	0.70
	Education	11.3	12.1	13.4	18.1	17.9	17.6
25 %	Inheritance	0.1	0.3	0.8	36	41	55
	Ability	0.42	0.52	0.60	0.78	0.71	0.71
	Education	11.8	12.6	13.9	18.3	18.0	17.9
30 %	Inheritance	0	0.3	0.7	32	38	49
	Ability	0.43	0.51	0.57	0.79	0.72	0.73
	Education	11.8	13.1	13.8	18.4	17.9	17.9

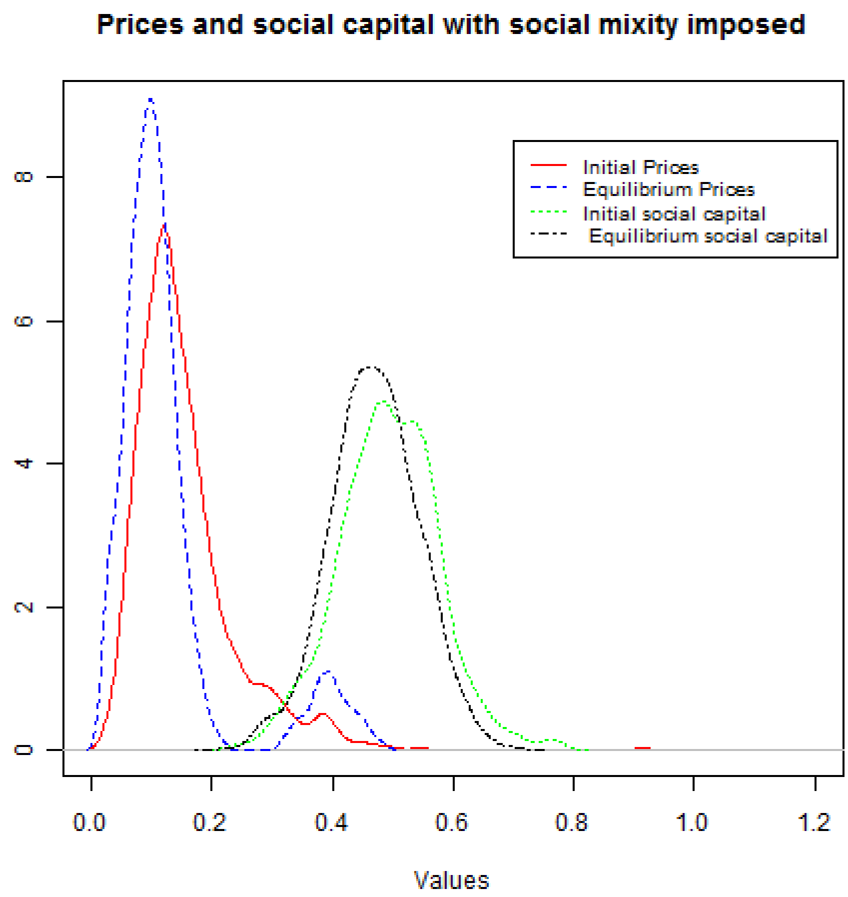
3.5.2.3 Diversity

The last policy consists of imposing to each location a minimum share of low educated individuals. I present the results with 15% of low educated individuals in each location. In Figure 3.11, the initial and equilibrium distributions of prices and social capital are plotted. The major effect is a reduction in the dispersion of both the level of prices and social capital. This policy acts as a bound to the average local social capital and holds back the growth of housing prices. Compared to alternative policies, this policy performs better because it softens the individual trade-off between neighborhoods. More precisely, it acts as the maximum level of social capital that prevent prices but also homeownership to increase as they do in the basic model.

Conclusion

In this paper, I proposed a model to study the outcomes of the housing, labor and education markets when local interactions matter. This paper makes several contributions

Figure 3.11: Prices and social capital with urban mix



to the literature. First, to my knowledge, this is the first paper to analyze homeownership decision with endogenous prices not derived from a construction sector but from rational expectations on future prices accounting for neighborhood quality. Second, the heterogeneity of locations combined with the dynamics of prices provides a powerful tool for analyzing the dynamics of inequalities. Third, frictions in the labor market and imperfections in the credit market create an insurance problem. Saving acts as a self-insurance mechanism against negative shocks. The trade-off between bonds and housing assets allow individual to diversify their investment thanks to the presence of transaction costs in the housing market. Finally, the introduction of a bequest motive allows to investigate the dynamics of generational inequalities.

The results show that the model performs well in explaining several stylized facts. A decomposition of the lifetime inequality demonstrates that bequest accounts for a sizable part of lifetime inequality, while the spatial inequalities account for approximately 25% of the overall inequalities. I carry several experiments using the model. One of the most interesting result is related to the relaxing of borrowing constraints. One of the main consequence of such a policy is to increase the level of prices. This outcome may be the explanation of the level of housing prices observed in the majority of the developed countries before the 2008 crisis. Among all the policies considered, a mix of bequest taxation and diversity policy would provide an efficient control for the level of spatial and generational inequalities. In practice, it may be argued that a policy of diversity is hard to implement. One should note that a similar policy exists in France. Instead of imposing a share of low educated individuals, it imposes to each location a minimum share of public housing. For a policy maker interested in decreasing lifetime inequalities, this is a good starting point.

Although the model presents several advantages, the results are subject to several modeling simplifications. First, the model does not consider education as a choice variable. A more appropriate human capital accumulation would have been suitable. Second, the highly parametrized frictions of the labor market should be replaced by a search model. These two natural extensions are left for future research.

General Conclusion

This thesis contains three essays on the causes of spatial inequalities and the policies that can be used to tackle them. The common feature of the three essays is that they propose a structural modelling of spatial inequalities. Thus, the individual choices are derived as the solution to an optimization problem over a long period of time. In the first essay, we estimate an optimal stopping model of individual mobility decision along with a hedonic model of optimal housing choice. In the second essay, I evaluate the French Enterprise Zones using an estimated search equilibrium model with endogenous spatial matching between firms and individuals. In the final essay, I investigate the long run consequences of segregation using an overlapping generation model with interactions between housing, labor, education and a bequest motive.

Despite the differences across the markets considered, the quantitative methods used and the type of equilibrium studied, these three essays share the same investigation of the causes of segregation, policy evaluation when facing discrepancy between locations and mobility patterns, and propose new policies to help circumvent the growing differences between locations in the long run.

In the first essay, we develop a framework to estimate the willingness to pay for the housing and location attributes in the presence of unobserved heterogeneity. We proposes an innovative estimation method of hedonic models showing that unbiased parameters can be obtained using tenure data, and an exogenous rent variation like rent control. In contrast to former literature, we use two sources of identification that complement each others. The characteristics of housing units and their inhabitants are used as in the hedonic literature along with the conditional probability of whether to move or stay. The estimation results demonstrate that unobserved housing characteristics matter, and since they are negatively correlated to the observed housing characteristics, the failure to account for them downwards the estimated parameters.

In the second essay, I investigate the effectiveness of the French Enterprise Zones policy. For this purpose, I develop a search model to account for the frictions in the labor market, and make of it an equilibrium model to account for the general equilibrium effects. The model generates segmentation between two locations by assuming the existence of agglomeration externalities, and search frictions that result into a lower job arrival rate when the firm and individual locations differ. The results show that the policy has very limited effect on unemployment. Further simulations indicate that the number of firms in FEZs should be multiplied by 20 in order to close the gap between them and the rest of the urban space. The decomposition of the job arrival rate highlights the importance of location specific effects, and the physical distance between workplace and residential locations. This evidence suggests a change in public policy strategy. That is, in the short run one may subsidize mobility of unemployed individuals, while in the long term invest in policies that are able to change the unobserved component of the deprived locations.

In the final essay, I analyze the determinants of differences across individuals, locations and generations. to the dynamics of inequalities. I develop an overlapping generation model where heterogeneous agents along dimensions like ability, education, and amount of inheritance live into heterogeneous locations. The locations are heterogenous with regard to the level of social capital which affects individual productivity in the labor market. The model shows that the current level of homeownership is higher than its value in equilibrium. Moreover, I report in equilibrium a much higher variance of prices compared to the initial ones observed in the data. The decomposition of lifetime inequalities shows that a sizeable share of long run inequalities comes from differences in bequest and spatial inequalities. Among the set of experiments considered, I show that a mix of bequest taxation and social mixity in each location would provide an efficient control for the spatial and generational inequalities.

Of course, these three essays are subject to limits that may constitute baseline for future research. In the first essay, our model does not permit to identify separately the housing unobserved characteristics from the neighborhood ones. Another source of identification would be required for that. Moreover, it would be of particular interest to extend the framework to allow for individual unobserved characteristics. The conditional choice probability based on length of stay may help for identification in the same way as in the literature on unobserved heterogeneity in duration models. Finally, a more suitable dataset would allowed us to introduce a real theory of location choice.

In the second essay, several difficulties related to the data quality forced me to over simplify the model. The evaluation of local tax holiday policies is particularly complicated by the need to model at the same time firms' location choice, individual search in the labor market, individual location choice, and the equilibrium effect of the policy on wage distributions. Though, the inclusion of equilibrium effects has its drawbacks. That is, the individual mobility part is not clearly connected to the labor market outcomes, complicated out of sample inferences based. With regard to this particular issue, one would prefer a partial equilibrium that would be less natural for the analysis of firms behavior. One needs to clearly think through all the possible avenues and makes the choice that yields the most suitable models. I believe that equilibrium effects remain an important aspect of the policy.

In the third essay, a natural extension would be to increase the sources of individuals' heterogeneity. In most respects, this will allow for a more realistic definition of social capital. Ideally, one would like to estimate this model. Estimation of macroeconomic models represents a great challenge, but worthwhile especially in topics that are policy-related as this one. The set of individual choices could be easily modeled within a likelihood approach. Furthermore, the model generates several moments. An approach building on Imai, Jain, and Ching (2009) and Chernozhukov and Hong (2003) should be feasible.

Appendix: Essay 2

A.1 Data selection

A.1.1 Labor market data

We restrict our attention to the continuous surveys, we select only individuals whose first interview data are available and may theoretically be interviewed at least four times. That is all the individuals interviewed for the first time between march 2003 and march 2008. The final sample selection is as follows:

- We apply the same selection criteria as Bontemps, Robin, and Van den Berg (1999). That is, we dispose of individuals who at some stage were students, in military force, retired, housewives, working in government jobs, and older than the legal retirement age
- We get rid of all individuals with a missing location identifier, and individuals located in a metropolitan area with no ZFUs.
- We dropped all the individuals for whom the firm identifier is missing making it impossible to recover the job location
- We drop all the cities with less than 40 individuals located in a FEZ

Another issue is related to the panel dimension of the labor survey. As pointed out before, the survey follows over six periods housing units and not individuals. Indeed, the method of survey is not the same depending on the period of interview. Data are collected on the field for the first and the last interviews while they are collected by phone from the second to the fifth interviews. This yields a high degree of unbalancedness in the sample, and may create a confusion between attrition and mobility.

The final sample is composed of 13,231 individuals located into 10 cities.

A.1.2 Mobility information

We start with the initial sample of the French Permanent Demographic Sample. This sample is obtained by picking the census files of individuals born between the 1^{st} and 4^{th} of October. This records a total sample of 2,152,175 individuals born between 1862 and 2009, with 1,617,380 individuals present in the annual surveys.

We dispose of all dead individuals not surveyed after 2004 (193,906). We get rid of individuals younger than 20 years because they are not old enough to have two observations in the time (554,932), individuals older than 100 years (16,471), and individuals not living in metropolitan France (744).

With this data at hand of 1,386,122 individuals, we focus on the period from 1990 to 2009. However, we have to cope with a substantial amount of *attrition* between the sample of 1990, 1999 and 2009. That is, we observe only around 350,000 individuals in both 1990, 1999 and in 2009 censuses. We ignore this issue and construct two samples. The first corresponds to individuals present at the same time in the 1990 and 1999 population censuses and is composed of around 500,000 individuals. The second represents individuals in both the 1999 and in one of the population censuses, which represents approximatively 350,000.

Table 3.9: Transitions between the rest of the space and the ZUS from 1990 to 2009

Individual Characteristics		Type of transitions from 1990 to 1999: Not Mobile	Non ZUS → Non ZUS	Non ZUS → ZUS	ZUS → Non ZUS	ZUS →ZUS
Age	20 - 24	7.5	9.8	16.1	10.0	14.1
	25 - 29	3.9	13.3	20.3	15.1	13.1
	30 - 39	8.6	26.8	30.1	37.1	22.8
	40 - 49	21.6	20.1	17.0	20.0	19.4
	50 - 59	21.8	13.2	9.3	9.4	14.8
	60 - 99	36.6	16.8	7.2	8.5	15.8
Male		45.9	47.3	45.5	46.4	44.5
Married/cohab		34.3	50.5	48.8	58.2	43.5
Citizenship	Native	96.3	96.6	92.8	92.3	86.4
	Immigrant	3.7	3.4	7.2	7.7	13.6
Education	No diploma	44.4	28.7	33.4	31.1	50.0
	Vocational	31.3	33.1	33.5	37.3	32.6
	High school	11.7	15.6	15.2	13.5	10.0
	Associates	6.3	11.3	9.2	9.9	4.3
	University	6.4	11.3	8.8	8.2	3.1
Job Status	Unemployed	10.5	11.3	22.9	15.3	26.7
Tenure	Homeownership	77.4	53.0	16.9	40.8	19.8
	Renting	18.4	38.9	74.8	51.5	73.5

Individual Characteristics		Type of transitions from 1999 to 2009: Not Mobile	Non ZUS → Non ZUS	Non ZUS → ZUS	ZUS → Non ZUS	ZUS →ZUS
Age	20 - 24	6.9	8.2	13.1	9.1	12.4
	25 - 29	4.0	10.8	16.5	10.7	14.7
	30 - 39	6.0	27.9	28.2	31.6	24.7
	40 - 49	15.8	22.3	18.1	23.3	19.0
	50 - 59	21.5	12.4	11.6	11.6	14.0
	60 - 99	45.8	18.4	12.5	13.7	15.1
Male		47.7	47.9	46.0	47.5	45.6
Married/cohab		34.3	34.9	51.1	34.9	49.2
Citizenship	Native	92.9	93.4	82.0	83.9	68.9
	Immigrant	7.1	6.6	18.0	16.1	31.1
Education	No diploma	36.3	20.2	24.4	26.1	41.6
	Vocational	34.4	31.8	30.1	36.2	33.5
	High school	14.1	19.3	19.8	16.6	12.6
	Associates	8.2	15.0	13.1	12.0	6.7
	University	7.1	13.8	12.6	9.1	5.6
Job Status	Unemployed	8.7	9.5	18.1	14.0	25.4
Tenure	Homeownership	80.6	51.3	22.7	41.4	15.0
	Renting	17.2	40.2	68.2	51.0	78.6

Table 3.10: Transitions between ZFU and the rest of the space ZFU

Individual Characteristics		Type of transitions from 1990 to 1999			
		Non ZFU → Non ZFU	Non ZFU → ZFU	ZFU → Non ZFU	ZFU →ZFU
Age	20 - 24	10.1	15.1	10.9	14.7
	25 - 29	13.5	15.6	17.3	17.4
	30 - 39	27.3	25.9	35.6	32.7
	40 - 49	20.0	18.9	18.8	16.1
	50 - 59	13.0	12.6	9.2	10.3
	60 - 99	16.1	11.8	8.2	8.8
Male		47.2	44.4	45.8	42.8
Married/cohab		50.7	46.4	57.0	53.6
Citizenship	Native	96.2	88.3	93.0	79.9
	Immigrant	3.8	11.7	7.0	20.1
Education	No diploma	29.3	42.1	31.7	51.5
	Vocational	33.3	33.9	37.7	33.8
	High school	15.3	12.4	13.6	7.3
	Associates	11.1	7.1	9.7	4.3
	University	11.0	4.5	7.3	3.1
Job Status	Unemployed	12.0	25.1	16.9	31.7
Tenure	Homeownership	51.0	19.6	39.4	13.8
	Renting	41.0	73.0	52.4	77.7
Individual Characteristics		Type of transitions from 1999 to 2009			
		Non ZFU → Non ZFU	Non ZFU → ZFU	ZFU → Non ZFU	ZFU →ZFU
Age	20 - 24	8.4	13.5	9.1	13.8
	25 - 29	10.9	17.9	10.6	14.3
	30 - 39	28.0	29.1	30.8	24.3
	40 - 49	22.3	15.2	23.4	16.9
	50 - 59	12.4	12.7	11.2	12.8
	60 - 99	18.0	11.6	14.9	12.9
Male		47.9	43.4	47.1	46.7
Married/cohab		35.2	49.1	37.2	48.8
Citizenship	Native	92.8	80.3	81.6	66.8
	Immigrant	7.2	19.7	18.4	33.2
Education	No diploma	20.5	27.6	27.2	42.2
	Vocational	31.9	31.2	36.7	35.4
	High school	19.2	18.1	16.6	13.0
	Associates	14.8	13.3	11.8	5.5
	University	13.6	9.9	7.6	3.9
Job Status	Unemployed	9.8	21.4	14.6	26.3
Tenure	Homeownership	50.2	23.0	41.3	14.9
	Renting	41.3	67.4	50.8	79.6

A.2 The likelihood functions

In order to understand the estimation algorithm, it is important to understand the formation of the likelihood. We consider individual transitions in the labor market, but the number of transitions that we can consider is highly constrained by the data. Let's start with some basic definitions. Assume, we observe an individual for the first interview. Its labor market position can be summarized:

$$d = \begin{cases} 1, & \text{if unemployed} \\ 0, & \text{if employed} \end{cases}$$

Its residential location can also be summarized as:

$$d_A = \begin{cases} 1, & \text{if the individual lives in A} \\ 0, & \text{if the individual lives in B} \end{cases}$$

Let's denote by w_e^0, the observed wage of employees at the first interview. w_u and w_e are respectively the wages accepted by an individual formerly unemployed and employed. The wage is recorded only at the first and the last interview. If we were to consider several transition to employment the accepted wage will be missing. Hence, in the best cases, we can consider up to two transitions per individuals. That is, for individuals initially unemployed, we can observe the initial unemployment spell denoted t_{up} or $d_{up} = 1$ indicating that the duration is censored. If there is no transition, we denote by t_{ur} the residual unemployment duration. Then, it follows that we can only consider the first transition to employment $d_{ue} = 1$ and the corresponding employment duration t_{uer} with no missing data issue. However, it may happen that this employment spell did not last until the 6^{th} interview, in that case the wage is missing, and we denote $d_{er} = 1$

Let's consider now an individual initially employed. We observe the initial employment spell t_{ep} or $d_{up} = 1$ indicating that the duration is censored. In this situation, the two possible cases are summarized by:

$$v^t = \begin{cases} 1, & \text{if job-to-unemployment transition in period t} \\ 0, & \text{if job-to-job transition} \end{cases}$$

Then, if individuals makes a job to job transition, we denote by t_{ee} the duration of its last transition which can be censored $d_{ee} = 1$. If the employment duration is not censored the wage accepted at the job-to job transition will be missing, and we do not consider the subsequent transition. If the individuals makes a transition to unemployment, we denote by t_{eu} the corresponding unemployment duration, and $d_{eur} = 1$ indicates that this duration is not censored.

We need also to define an additional dummy for the location where the job has been found:

$$d_a^t = \begin{cases} 1, & \text{if individual makes a transition to a job in A in period t} \\ 0, & \text{If individual makes a transition to a job in Z in period t} \end{cases}$$

Finally, we need to define a dummies indicating a transition in the housing market:

$$d_m = \begin{cases} 1, & \text{if individual does not move} \\ 0, & \text{if individual does move} \end{cases}$$

We are now in position of defining the likelihood. We derive the contribution to the likelihood of an observation, the sample analog is obtained by taking the product.
For notation convenience, we will omit the individual index in this subsection. Let's start with an unemployed individual drawn in the location A. The model provides the probability to draw such an individual and it is given by $\frac{u^A}{m^A}$. Its contribution can be written

$$\mathcal{L}_u^A = \frac{u^A}{m^A}[\lambda_u^{AA}\lambda_u^{ZA}]^{1-d_{up}} \exp\Big(- \big[\lambda_u^{AA}\lambda_u^{ZA}\big]\big[t_{up}+t_{ur}\big]\Big)$$
$$\Big[\Big[\big[\lambda_u^{AA}[f^A(w_u)-\theta_{AA}]\Big]^{d_a^1}\big[\lambda_u^{ZA}[f^Z(w_u)-\theta_{AZ}]\big]^{1-d_a^1}\Big]\Big]^{d_m\times d_{ur}^1}$$
$$\Bigg[\exp\big\{ - \big[\delta+[\lambda_e^{AA}\lambda_e^{ZA}]\bar{F}(w_e)\big]t_{eur}\big\}\Big[\big\{\delta^{v^1}\big[[\lambda_e^{AA}]^{d_a^2}[\lambda_e^{ZA}]^{1-d_a^2}\big]^{1-v^1}\big\}\Big]^{d_{er}}\Bigg]^{d_m}$$

We can move to the contribution of an individual who was employed at the time of the first interview. The corresponding probability to be sampled is given by $\frac{m^A-u^A}{m^A}$. This likelihood is similar to be one of individuals initially unemployed,

$$\mathcal{L}_e^A = \frac{m^A-u^A}{m^A}.g^A(w_e).\Big[\delta+[\lambda_e^{AA}\lambda_e^{ZA}]\bar{F}(w_e)\Big]^{1-d_{ep}}$$
$$\Bigg[\exp\big\{ - \big[\delta+[\lambda_e^{AA}\lambda_e^{ZA}]\bar{F}(w_e)\big]t_{er}\big\}\Big[\big\{\delta^{v^1}\big[[\lambda_e^{AA}]^{d_a^1}[\lambda_e^{ZA}]^{1-d_a^1}\big]^{1-v^1}\big\}\Big]^{1-d_{er}}\Bigg]^{d_m}$$
$$\Bigg[\Big[\exp\Big(- \big[\lambda_u^{AA}\lambda_u^{ZA}\big]\big[t_{eur}\big]\Big)\Big[\big[\lambda_u^{AA}[f^A(w_u)-\theta_{AA}]\big]^{d_a^2}\big[\lambda_u^{ZA}-[f^B(w_u)-\theta_{AZ}]\big]^{1-d_a^2}\Big]^{1-d_{eur}}\Big]^{v1}\Bigg]^{d_m}$$

We do not consider a potential third job-to-job transition. The corresponding likelihoods for an individual initially living in Z are symmetric, and are written $\mathcal{L}_u^Z$ and $\mathcal{L}_e^Z$.

Thus, the total contribution of the labor market to the likelihood $\mathcal{L}_l$ can be derived

$$\mathcal{L}_l = \big[\mathcal{L}_u^A\big]^{d_A\times d}\big[\mathcal{L}_e^A\big]^{d_A\times[1-d]}\big[\mathcal{L}_e^A\big]^{[1-d_A]\times[1-d]}\big[\mathcal{L}_u^A\big]^{[1-d_A]\times d} \tag{3.15}$$

Finally, we can write the likelihood associated to firm mobility.

$$\mathcal{L}_f(w,\mu) = \prod_{j=1}^{N}\prod_{t}^{T}\prod_{k}^{K}\Big[Pr(k,w,\mu_j)\Big]^{d_k^t}\Big[1-Pr(k,w,\mu_j)\Big]^{1-d_k^t} \tag{3.16}$$

Where d_k^t is a dummy indicating whether or not firm j makes the choices k in period t.

At last, let us consider the cases where a wage is missing. Depending on the type of transition, we sample a new wage using a simple Metropolis Sampler. For each observation missing, we can find a nearest estimator:

- For an individual initially employed, $w^s = w_e + \epsilon$
- For an individual initially unemployed, $w^s = w_u + \epsilon$ where w_u is the wage accepted by workers of the same type as the individual.

The wage is drawn as follows: draw the candidate wage w^* from the proposal density $\pi_w(w^*|w^{(s)})$. Then, derive the acceptance probability

$$P_a = min\left\{ \frac{w^* \pi_w(w^{(s)}|w^*)}{w^{(s)} \pi_w(w^*|w^{(s)})}, 1 \right\} \tag{3.17}$$

That is, let $w^{(s+1)} = w^*$ (i.e., accept) with probability P_a and let $w^{(s+1)} = w^{(s)}$ (i.e., reject) with probability $1 - P_a$. Then, we sample 100 new wages. The individual wage is obtained by taking the mean.

Appendix: Essay3

A.2.1 List of notations

Table 3.11: List of notations

Variables	Definition	Value/ grid
Indexes		
i	individual index	
n	neighborhood index	
Aggregate variables		
Y	Production	20 points
G	Government expenditures	-
K	Capital	20 points
l	unit of labor productivity with $\sum l = L$	40 points
State and choice variables		
a	Age	20 - 85
b	bonds (wealth)	700 points
c	Consumption (goods)	15 points
d	Unemployment benefit	$0.8 * \underline{w}$
e	Labor market status	-
h	Consumption (housing)	15 points
j	individual ability	0-1
ι	tenure	-
p	housing price	-
q	rent	-
r	interest rate	0.04
$\tilde{T}$	Age of retirement	65
y	Individual income	-
w	human capital	9-20
z	neighborhood level of social capital	0-1
Parameters		
α	capital share	0.32
β	discount rate	0.95
θ	deterministic probability to survive	see text
Γ	family size	see text
ψ	inherited or transmitted wealth	0.25
ς	Parent's degree of altruism towards her child	0.17
σ	share of housing	0.30
γ	inverse of inter-temporal elasticity of substitution	2
ϖ	wage rate	
χ	product per unit of labor productivity	
t_y	tax rate on income	0.20
t	tax rate on capital interest	0.07
t_r	tax rate on renters	0.016
t_{pr}	tax rate for real estate agencies	0.003
t_p	tax rate for homeowners	0.005
δ_h	depreciation rate for housing	0.015
δ_k	depreciation rate for capital	0.01
τ_h	transaction cost	0.15
λ	Job arrival rate	see text
ϑ	Job destruction rate	0.04
κ	downpayment rate	0.3
Π	distribution over population, $\Pi_a, \Pi_Z, \Pi_W, \Pi_J, \Pi_{bn}$	

A.2.2 Computation details

A.2.2.1 Updating procedure of housing prices

Initial prices : Let's assume that the prices are constant:

$$p_1^n = p_2^n = p_3^n = \ldots = \ldots = p_t^n == p_{t+1}^n == p_{T-1}^n == p_T^n \qquad \text{or put differently} \qquad \frac{p_{T-1}^n}{p_T^n} = 1$$

Under constant price assumption, using former simulations, I can derive housing demand $H_t^D = H_t^{H^D} + H_t^{R^D}$ t for each period in each neighborhood. However, the prices determination require only housing demand for homeowners. Housing supply is exogenous in our model and given by $H_t^S = H_t^{H^S} + H_t^{R^S}$. The equilibrium price at t=1, $p_1^{n(1)}$, is determined by market clearing condition $H_t^{H^S} = H_t^{R^S}$

Update and convergence I assume that for the sequences k-1 and k of equilibrium prices, the ratio between period is constant: $\dfrac{p_{t+1}^{n(k)}}{p_t^{n(k)}} = \dfrac{p_{t+1}^{n(k-1)}}{p_t^{n(k-1)}} \qquad \forall k$

The equilibrium prices are derived assuming that the ratio between current and next prices are the same as in the first sequence $\{p_t^{n(1)}\}_{t=1}^T$. Since the prices of the first sequence are recovered from the constant price assumption, I can expect their ratio to speed-up the convergence. At time t = 1, I derive housing demand under the constant price ratio assumption, and derive $\{p_t^{n(2)}\}_{t=1}^T$. Using the same strategy, I can recover the entire sequence $\{p_t^{n(2)}\}_{t=1}^T$.

Finally, I keep updating using the former price ratio until $|\{p_t^{n(k)}\}_{t=1}^T - \{p_t^{n(1)}\}_{t=1}^T|$ where ϵ is a defined criterion. The corresponding prices are the rational expectation equilibrium prices and given by $\{p_t^n\}_{t=1}^T$

A.2.2.2 Discretization and Parametrization

Family size and consumption In order to adjust the housing and consumption profile for a typical household I use a household equivalence scale. The aim is to keep the welfare of the family constant as the family size varies over the life-cycle.

Table 3.12: Family size and consumption

Family size	Housing consumption	Goods consumption
1	100	100
2	120	130
3	150	160
4	180	205
5	210	250

Equivalence scale between housing and non housing consumption obtained using the Survey of life conditions.

Education: I assume that the education level acquired by an individual is a function of its birth neighborhood and its ability. The levels of education goes from 9 to 20. I bound the minimum level of education to reflect the fact that education is compulsory until age 16. Half of education is due to ability, and half to the birth neighborhood. It may be argued that locations do not reflect half of educational differences across individuals. The location served two purposes: it reflects the human capital acquisition cost, and

Life and death: The probability to survive are derived from the *INED* tables of life expectancy.[16]. I scaled the expectancy tables such that at age 80 the survival rate is equal to 0. The corresponding survival probability is given by Figure 3.12.

The level of social capital: I define the level of social capital z to be a function of three variables evaluated at the neighborhood level: mean education level, unemployment rate and the homeownership rate. The precise specification is the following.

$$z_n = a_1.edu_n + a_2.unemp_n + a_3.home_n \tag{3.18}$$

In this specification, I put a higher weight on education. I specify a_1, a_2 and a_3 such that respectively 55%, 30% and 15 % of the level of social capital are explained by education, unemployment and homeownership rate. The nonparametric density is given by Figure 3.13.

[16] **I**nstitut **N**ational des **E**tudes **d**emographiques is the French office for demographic studies

Figure 3.12: Survival over the life cycle

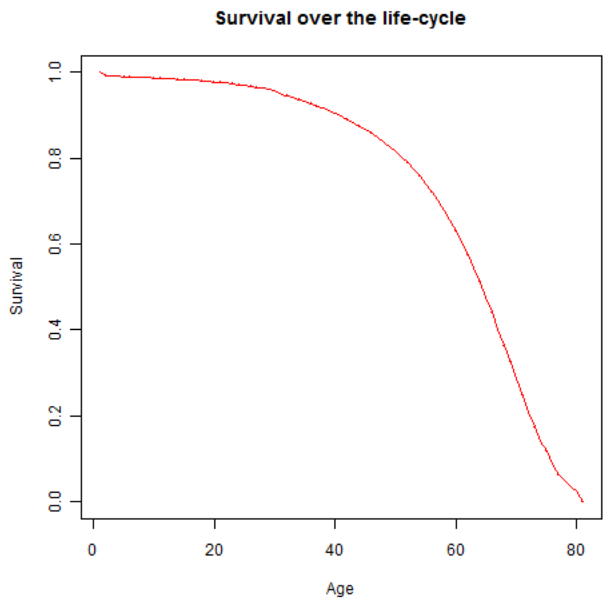
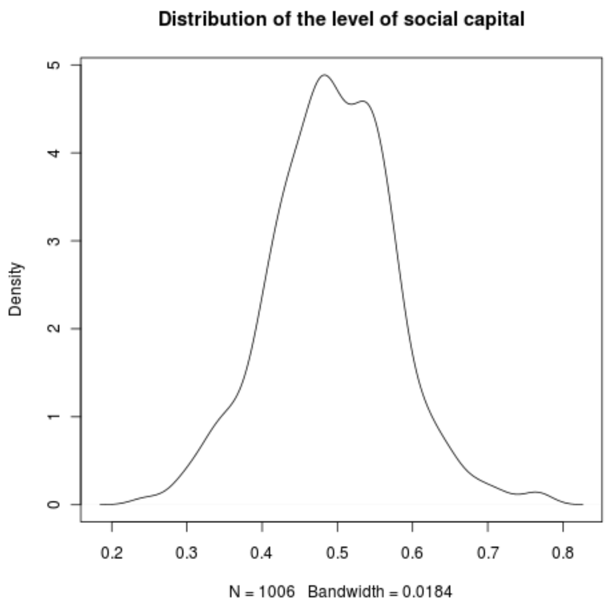


Figure 3.13: Nonparametric density of social capital



The productivity process: The productivity function is given by:

$$l_a jzw = \sum_a b_1 * l_a + b_2 * l_j + b_3 * l_z + b4 * l_w \tag{3.19}$$

In order to get the parameters b, I estimate this equation on the labor surveys and replacing individual unobserved by a fixed effect. After extensive analysis, I choose the parameters b such that 40% of the wage is explained by education. The three others variables (age, location, ability) account each for 20% of the productivity.

I assume the following structure between age and productivity.

$$\begin{aligned} l_a &= \sqrt{a} \quad \text{if} \quad 20 < a < 30 \\ l_a &= l_{a-1} + \log(a+1) - \log(a) \quad \text{if} \quad 31 < a < 45 \\ l_a &= l_{a-1} + \sqrt{(a+1)} - \sqrt{(a)} \quad \text{if} \quad 46 < a < 66 \end{aligned}$$

Figure 3.14: Wage over the life cycle

Labor market: I assume that labor market is equilibrium. That is, the flow of workers finding a job is similar to the flow of workers laid-off. I need to assume how individuals leave unemployment. To do so, I estimate using the 2002 Labor Survey, a duration model of unemployment. I estimate a hazard function out of unemployment. This yields a negative time-dependency. Moreover, for each neighborhood a hazard rate out of unemployment is estimated.

Once the initial job arrival is set-up, its evolution follows a first-order markov process. The level of autocorrelation over time is assumed to be proportional to changes in the level of social capital.

Initial school differences: The distribution of i^f is simulated to fit the differences between locations in high school graduation rates.

Matching the model and the data at the initial period: To produce a good fit, several calibrations are imposed by the model. First, the wage rate is used to match the wage profile over the life-cycle. In addition, the interest rate along with assumptions on the productivity process help fitting the unemployment rate over the life-cycle. Spatial differences in unemployment is captured by a calibrated neighborhood-specific job arrival. Spatial differences in the wage profile are captured through the initial distribution of education and social capital across locations.

It is not trivial to match the moments of the housing market. However, the depreciation rate of housing, the initial distribution of prices, the residential and property taxes are very useful tools in matching both the mean homeownership rate and its distribution over locations. Our calibrated parameters are obtained after a fine tuning allowing to match the data and the model at the initial period.

Finally, it is not trivial to match the wealth distribution. Nonetheless, it turns out that the work achieved on the housing market helps fitting the shape and the left-tail of the wealth distribution. In the dynamic setup, the evolution of prices succeeds in matching the top percentiles. The local differences in the outcome of the housing market generates a local wealth distribution that fits extremely well the data.

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Modibo SIDIBE

Abstract

This dissertation consists of three essays on the structural analysis of spatial inequalities. The first two essays rely on estimated parameters while the third is a fully calibrated model. In the first essay, we investigate the magnitude of individual willingness to pay for housing and neighborhood attributes by estimating a dynamic hedonic model. We use the mobility choice from the housing tenure data and the observed hedonic housing characteristics as the main sources of identification. Our results show that the observed and unobserved housing characteristics are negatively correlated. Failure to take into account the endogeneity bias could underestimate the true value of the observed characteristics of housing. In the second essay, I propose an equilibrium search model to assess the effectiveness of the French Employment Zones Policies. Each metropolitan area is considered as a local labor market that consists of a central location and an inner suburb. Firms and individuals may decide to move as an outcome of the policy. The results demonstrates that the policy has very limited effect on unemployment. Further investigations indicate that for the policy to work, the number of firms in ZFUs should be multiplied by 20, which constitutes an objective out of reach. Finally, in the third essay, I analyze the contribution of differences across individuals and locations to the dynamics of segregation and inequalities. I develop a Bewley-Huggett-Aiyagari type model where several frictions are represented. More precisely, we allow for segmentation between homeowners and renters in the housing market, imperfection in the capital market and individual mobility over the life-cycle. The dynamics of price combined to bequest motive provide the perfect framework to understand the tenure choice of individuals.

Keywords: Structural dynamic model; equilibrium search; Overlapping Generation model; Hedonic; Policy evaluation; intergenerational inequalities

Résumé

Cette thèse présente trois articles où des agents optimisateurs tiennent compte dans leurs choix présents de leurs situations futures. Dans le premier essai, nous estimons un modèle dynamique de choix de logement. Nous nous intéressons à la disponibilité à payer pour les caractéristiques du logement en estimant un modèle hédonique dynamique. Notre méthode d'estimation tient compte des caractéristiques inobservables du logement, qui peuvent être de surcroît corrélées aux caractéristiques observées. Nous utilisons la régulation des loyers comme principale source d'identification, qui rend les loyers indépendants des conditions locales du marché du logement. Les résultats indiquent une corrélation négative entre l'hétérogénéité non observée et les paramètres. L'impossibilité de tenir compte de cette hétérogénéité biaiserait les paramètres. Dans le deuxième essai, nous proposons un modèle d'appariement sur le marché du travail pour évaluer la politique publique des zones franches urbaines. Nous modélisons chaque aire urbaine comme un marché local du travail composé d'une localisation centrale et d'une banlieue. Les firmes font des choix de localisation en fonction de leur productivité. La segmentation ainsi générée crée une différence entre les taux d'arrivée des offres des deux localisations. Les résultats démontrent que la politique a un effet très faible sur le chômage. De plus, le modèle suggère qu'il faudrait multiplier par 20 le nombre de firmes en ZFUs afin d'avoir un effet sur le chômage. Enfin, dans le troisième essai, nous analysons la contribution respective des différences individuelles et entre localisations à la dynamique de la ségrégation et des inégalités. Nous développons un modèle dans l'esprit de Bewley-Huggett-Aiyagari où plusieurs frictions sont présentes. Plus précisément, nous introduisons une segmentation entre les propriétaires et les locataires, l'imperfection du marché du crédit et la mobilité au cours du cycle de vie. De plus, la localisation des individus affecte leur productivité, leur accumulation de capital via la dynamique des prix des logements, et le processus d'acquisition de capital humain de la génération. Nous analysons ainsi la mobilité individuelle à partir de ce cadre de travail.

Mots Clés : Modèles dynamiques structurels ; Modèles de recherche d'emploi d'équilibre ; Modèles à générations imbriquées ; modèle hédonique, Evaluation de politiques publiques, inégalités entre générations